TELESCOPE MAKING 10

ISSN 0190-5570

The magazine *for*, *by*, and *about* telescope makers!

Winter 1980/81

Astrofest 1980 • Building a Garage-Top Observatory
Poncet on the Poncet • Calculators • John Brashear
Rolling Ridge Observatory • A Telescope for Children
Two Drive Correctors • Safe Solar Filtration • and more

TELESCOPE MAKING

The magazine *for*, *by* and *about* telescope makers!

Editor: Richard Berry

Associate Editor: Robert E. Cox

Managing Editor: Katherine M. King

TELESCOPE MAKING (ISSN 0190-5570) is published quarterly by AstroMedia Corp., 411 E. Mason St., P.O. Box 92788, Milwaukee WI 53202.
Copyright © 1981 by AstroMedia Corp., all rights reserved. No part of this issue may be reproduced by any mechanical, photographic or electronic process or otherwise copied for public or private use without written permission of the publisher. The opinions expressed in this magazine are not necessarily those of the publisher or editors.
POSTMASTER: When undeliverable, send form 3579 to publisher. Direct all inquiries, complaints, editorial submissions, and other correspondence to: TELESCOPE MAKING, 411 E. Mason St., P.O. Box 92788, Milwaukee, WI 53202; telephone (414) 276-2689. Not responsible for unsolicited materials. Names and addresses of authors will be printed unless specifically requested otherwise. Subscription price (U.S.): 1 year $8.00; single issues $2.00; other countries: 1 year $9.00, single issues $2.25. Clubs and dealers: Inquire about bulk rates. Copy Editor: Ross Simons: Typing: Dianne Precourt Cuneo & Mari Wing; Art Assistants: Jane Borth and Mary MacAdam; Advertising: Robert Schmall. Printed by Port Publications, Port Washington, WI.

In this issue...

2 Editorial
3 Letters
4 Build a Garage-Top Observatory
by Ronald McDaniel
8 Rolling Ridge Observatory
by Robert Reisenweber
11 Installing Bigger Circles
by Jack Huerkamp
12 Poncet on the Poncet
by Adrien Poncet
14 Safe Solar Filtration
by Ralph Dakin
16 John A. Brashear
by Mark Urbaetis
20 Calculators for Telescope Design
by Robert E. Cox and David Stolzman
24 Astrofest 1980
by Richard Berry
34 A Telescope for Children
by David Levy
36 A Basic RC Drive Corrector
by James Bailey
38 A Crystal Controlled Drive Corrector
by Bob Mulford
44 Blue Pages Classified Product Directory

Editorial

At the 1980 Riverside Telescope Makers Conference, I was honored and pleased to receive the Clifford W. Holmes Award. This award — from the Riverside Astronomical Society, and Richard Poremba and Luther Davisson of Astronomy for America — recognizes work in promoting amateur telescope making, something that I have done during my lifetime. It truly is a wonderful hobby — especially when one's peers are so gracious as to reward one for doing something that, by itself, brings only the greatest satisfaction. I am deeply grateful.

However, I am only "paying my debt" for all the information and experience passed on to me by the leaders in this hobby back in the 1930s. I had the privilege of meeting Russell W. Porter a number of times at Stellafane and asking him question after question about telescopes and the testing of them. Wally Everest invited the members of our New York Club to his home in Pittsfield after the Vermont meetings, and we all had a fine time discussing optics and fabrication techniques. Albert G. Ingalls was the most helpful, and I am proud to say that from 1935 until his death I was privileged to call him my friend and adviser.

Besides my thanks to these honorable gentlemen, I wish to thank *Sky and Telescope* for the 20 years of service I was able to extend to the telescope making hobbyist through their "Gleanings for ATMs" column. My special thanks to the AstroMedia Corporation (and in particular Richard Berry) for the opportunity to continue my service to others in both ASTRONOMY and TELESCOPE MAKING.

Your Chance to Subscribe (if you don't already)

☐ **TM is great! Please enter my subscription for two years (8 issues). Enclosed is $16.**

☐ **Enter my one year subscription right away! Enclosed is $8.**

Your subscription will begin with the next issue published. Domestic subscription rate: $8 per year; foreign: $9 per year. Payment must accompany your order. All back issues available at $2 each.

Name _____

Address _____

City/State/Zip _____

Mail to: Telescope Making
Circulation Department
P. O. Box 92788
Milwaukee, WI 53202

It is important that you, the reader, realize that the success of anyone who provides you a service also depends on your help and cooperation: it cannot be a one-way or a one-person situation. Besides writing material for a publication, an editor is responsible for knowing what you want to read about, securing new material, evaluating its correctness, completeness, and importance, and then presenting it in the publication. If I can find someone who can present an article on some subject, even one which I might do myself, I'll use the reader's material first. Why? Different writers express themselves in varying ways, which adds variety, clarity, and interest to articles.

In today's modern computer world, it might be appropriate to think of an editor as a storage or memory bank. Using "data" from our contributors and from our own experience, we provide the answers, through a "communications link" — this magazine, to the inquiries that we receive. Help us keep our "data banks" full. Send in those unusual and interesting ideas and stories so Richard and I can continue to service the telescope making community.

Incidentally, the award mentioned at the start of this editorial is *our* award. You, the readers and contributors from the past, now, and in the future, deserve it also. Without you, it would not have been possible for me to write about telescopes for so many years. I will proudly hold and take care of this award for all of us in grateful remembrance of the many wonderful friends in telescope making.

Sincerely,

Robert E. Cox

Robert E. Cox

Letters

Glass, Glass, Glass!

Sirs / I am designing the mount and parts for an 18-inch f/5 Dobsonian. I am writing because I need an 18-inch plate glass mirror for the main optics and I haven't the faintest idea where glass is sold nor how much it costs. A Pyrex mirror would be too heavy and too expensive, since I am in ninth grade. Also I think it would be better if you picked out the mirror and sent it to me here in New York.

Paul Diaz
97-40 62 Drive
Rego Park, NY 11374

— Glass is hard to find or expensive these days. I think you're best off if you buy plate glass locally — you can usually find plate glass up to an inch thick through the Yellow Pages under "Glass" — call around and ask lots of questions. Such glass is used for tabletops. Avoid something called Herculite, a highly stressed glass made to be shatterproof. Here in Milwaukee, an 18-inch circle of plate glass costs about $75.

TM would appreciate reader input on sources and prices for glass blanks, Pyrex or otherwise, from the readership. I think that glass supplies are the limiting factor for a lot of potential builders of large telescopes. -RLB

Richer-than-Richest Field

Dear Sir: I am interested in viewing deep-sky objects, and I have ordered a Deep-Sky Newtonian with a focal ratio of f/2.9. I have doubts whether or not a focal ratio of f/2.9 is practical or not. Would I be any better off with one of f/5? Any information or suggestions you have would be appreciated.

Dean McMillan
Grove City, OH 43123

— The focal ratio of the objective is NOT the determining factor in image brightness — exit pupil is. Used with a 20 mm eyepiece, you'll have a 7 mm exit pupil and the same field brightness and magnification of an f/5 telescope and a 32 mm eyepiece. Using the Newtonian Aberration Chart in TM#9, it appears that coma will be about twice as bad as it would be with an f/5 focal ratio, and for photography, the field will be quite small. Such a fast telescope must also have a large diagonal mirror.

Mailbag Hash

Dear Mr. Berry / I have made my own 6-inch mirror, and would like to know how to adapt the Dobsonian design to the size I need.

Miss Kim Berry
c/o Karen Minihan
Columbia High School
Rt. 2, Box 27-B
White Salmon, WA 98672

Dear Kim Berry / The dimensions of the Dobsonian are not very critical. I'd suggest you make careful scale drawings to aid you in dimensioning, then simply follow the directions given by Bob Kestner in TM#5.

Moving Correctors

Sir / I have recently become interested in astronomy and telescopes. I have had a few ideas on what I think might be new types of telescopes, and I thought that you could give me some advice or information concerning them.

The first idea: Could a correcting lens, like a Schmidt or Maksutov, be used after the primary mirror, somewhere in the converging light beam? This would reduce the size and cost of the corrector and telescope. Some new type of corrector might have to be designed, and other modifications might be necessary, too.

The second idea: Could a spherical convex secondary mirror be used in a Cassegrain reflector? It seems that it could cancel the spherical aberration caused by a spherical primary mirror.

In *Optics*, Irving D. Gluck states "Spherical aberration is also corrected by combining one lens with another. If a convex and concave lens of suitable curves are combined, the spherical aberration of each will be in the

41➤

How to Build a Garage-Top Observatory

My observatory's story begins on a September night in 1975. It was clear, and I was trying to observe the good sky events for that night. All my observing problems became reality — something had to be done about those pesky mosquitoes. They were making me mad! (If you live in a big city and have a small city lot and a good view of the sky so you observe a lot, you will know what I'm talking about.)

So I set out to find a dome to house my telescope, but found the prices were out of reach for me and my lot. Still, the more I looked, the more I was determined to build one. But where would I put it? There seemed to be no space except on top of my garage. The more I thought about it, the more I could picture the observatory up there.

I planned to build my dome out of ¼" plywood but a few experiments showed the wood wouldn't bend enough, so I changed to ⅛" masonite. As you can see, it turned out OK. I had no problems with my neighbors or the Akron City Building Dept. The 8-foot dome, built in my garage, was started with a 5"-wide base ring built up from three layers of wood. Twenty-four inside ribs ⅛" x 1½" were placed around the ring and screwed to a 12" round plate on top of a post in the center of the ring. This helped form the curve of the dome.

The skin of the dome is formed from 24 A-shaped panels 12" wide at the base and 48" high. They taper evenly to meet the ribs in the center. In one day, I glued and clamped every other panel in place; then the second day added the second set of panels to fill the spaces left. A second set of outside ribs were glued on, and then ⅛" bolts and nuts ¾" long were added every 6" along each rib to make a tight joint. The upper part of the dome panels was cut and added the same way.

After all the panels were in place, I cut out the hole for the shutter and glued a 2½" frame into place. The shutter door

was built to fit outside the frame and to lift off. Three coats of weatherproof paint were applied to the outside and one coat to the inside.

The opening in the garage roof was cut in by dropping a line through the ridge board to the floor of the garage ceiling. An 8-foot circle was marked on the floor, then the 8-foot circle was plumbed back up to the roof. I drilled a series of ¼" holes through the roof to mark the shape, and then cut it out.

Next a 4"-thick wall 5 feet high, built out of 2 x 4s, was added. The outside wall above the roof is covered with a fiberglass corrugated panel. The inside wall was insulated and covered with decorative wood paneling.

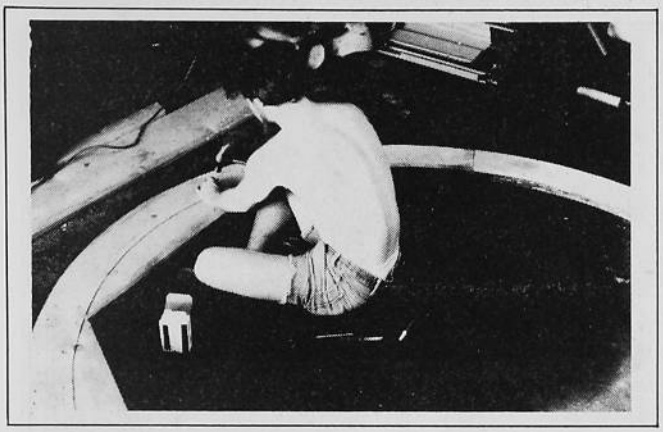
Raising the dome to the top of the garage was done by pushing the dome up extension ladders to the observatory. The dome weighs approximately 200 pounds, so my three sons helped with this.

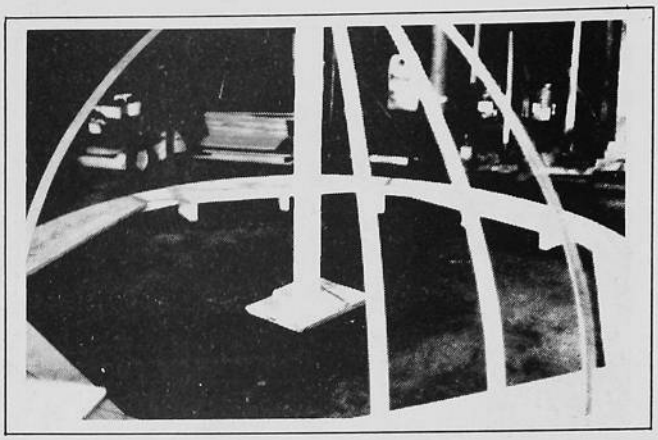
The dome turns on eight 2" rubber rollers placed on top of the wall under the dome plate. It is kept centered by rollers that run along the inside wall of the observatory. It rotates easily by hand. To observe, the shutter is lifted out at the bottom, up and off at the top, and placed on the ridge of the garage roof. The shutter is made out of the same material as the dome and weighs approximately 25 pounds. To keep the dome securely on in high winds, a pin-locking channel was built in to the top of the wall inside.

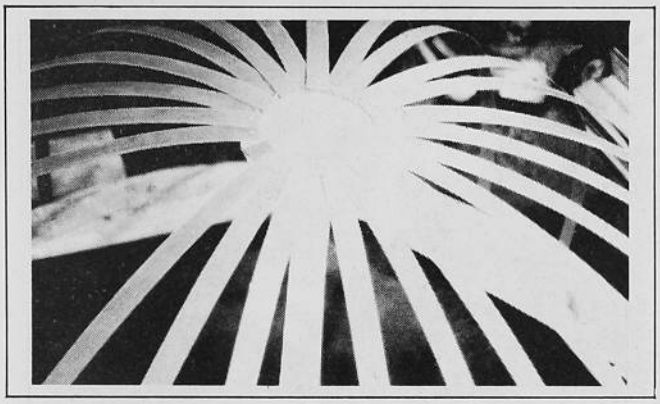
Later on a blower from a furnace was installed on the floor outside the observatory wall under the roof, and the outside air is added to the room if needed in the summer.

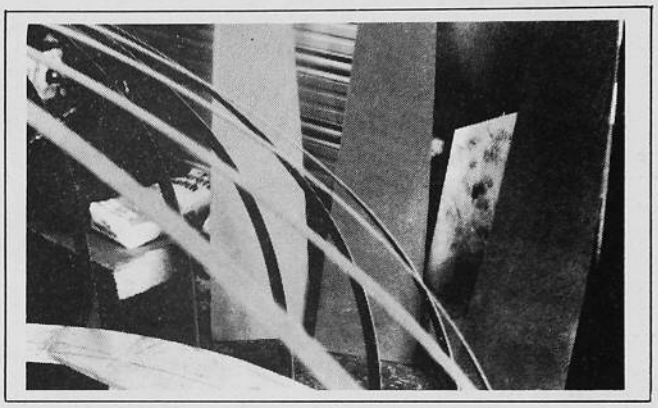
The observing room is 8′ in diameter with 5′ walls. At its highest point, the dome is 9′ from the floor. My observatory will hold four to six persons at a time.

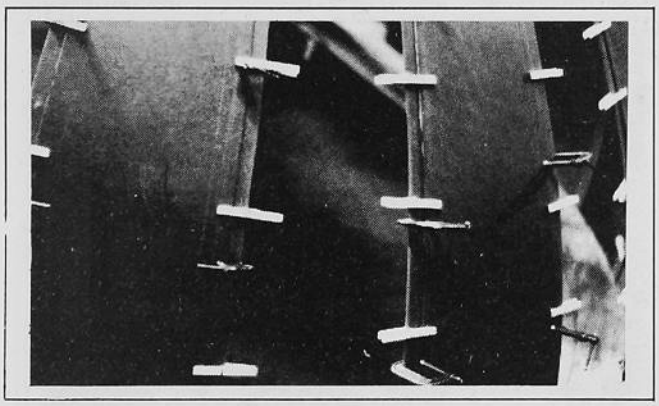
Eight red 15-watt lights with red lenses were installed along the perimeter inside the dome for interior illumination. A switch by the door turns the lights on and

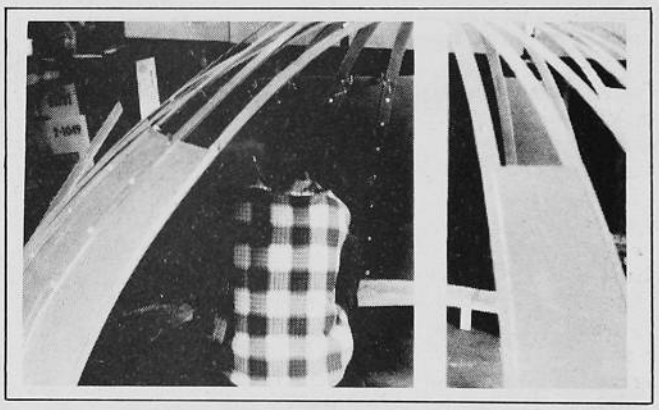


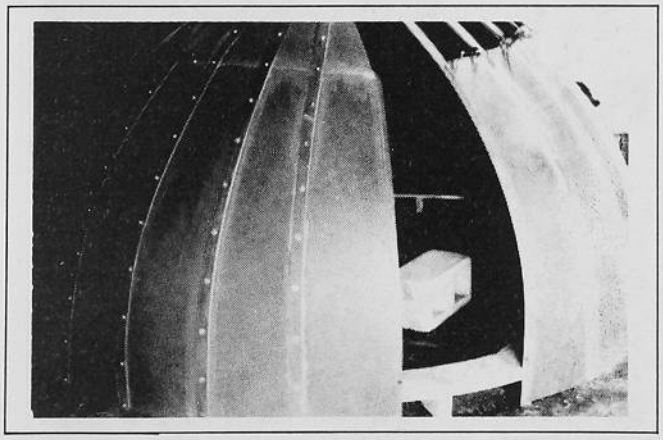


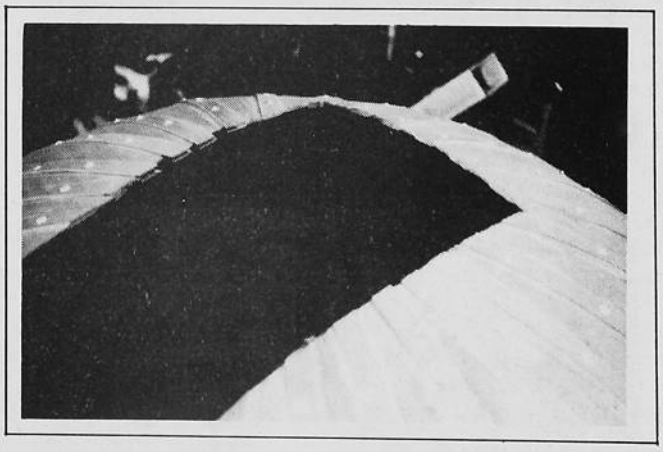


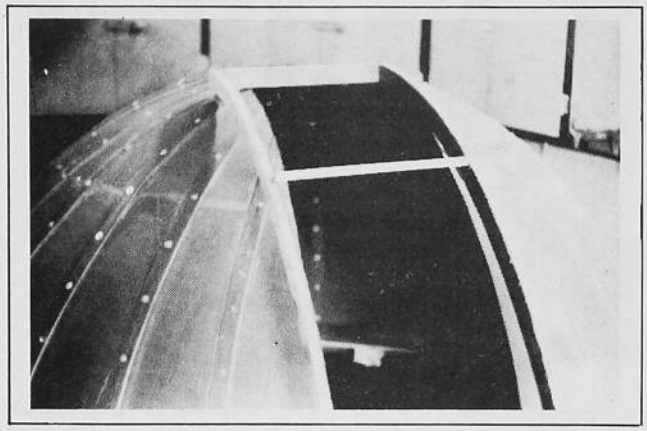


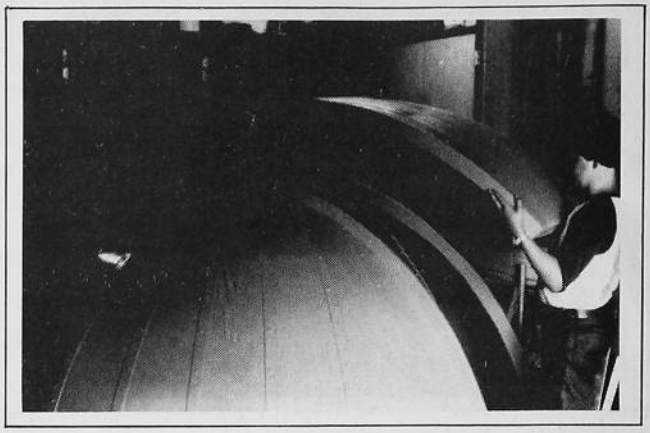


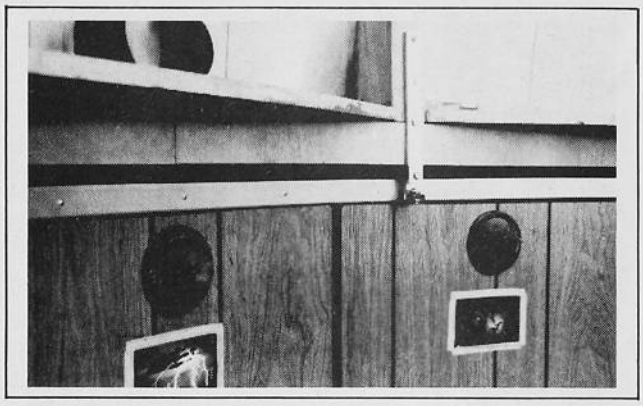


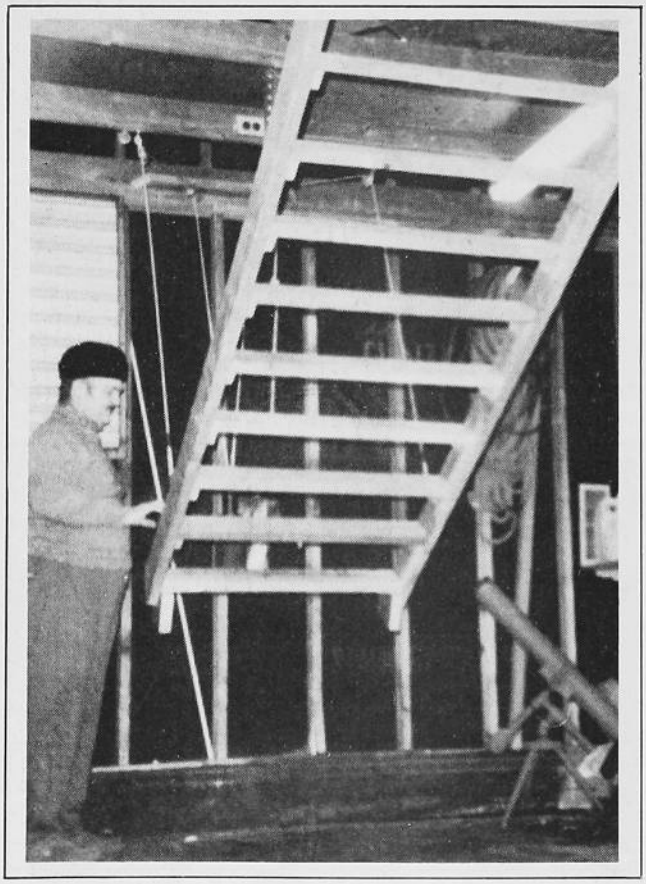


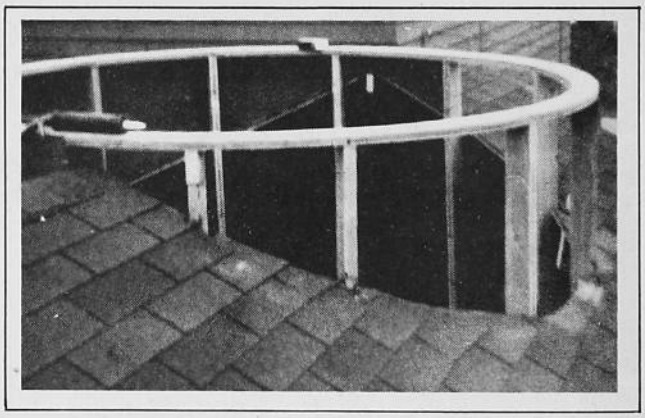












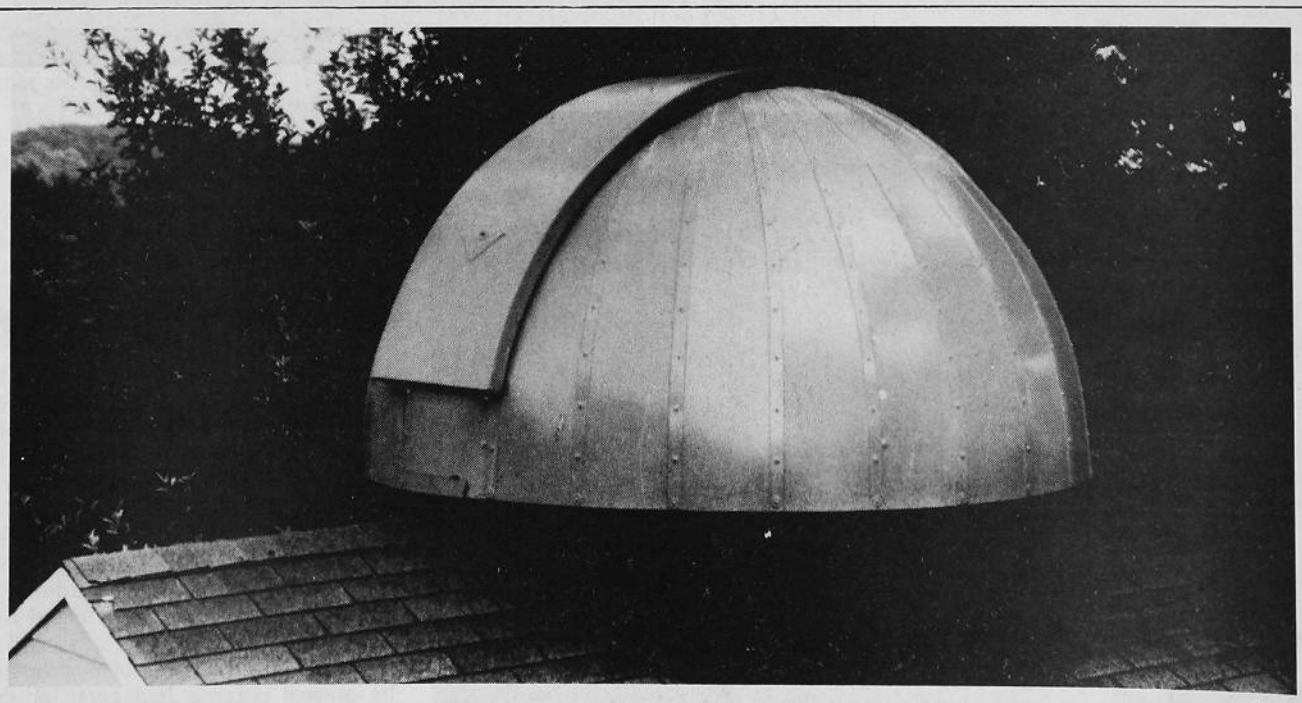
off when needed. The observatory used to house a 10-inch f/5.5 reflector, but now I'm looking for a better telescope.

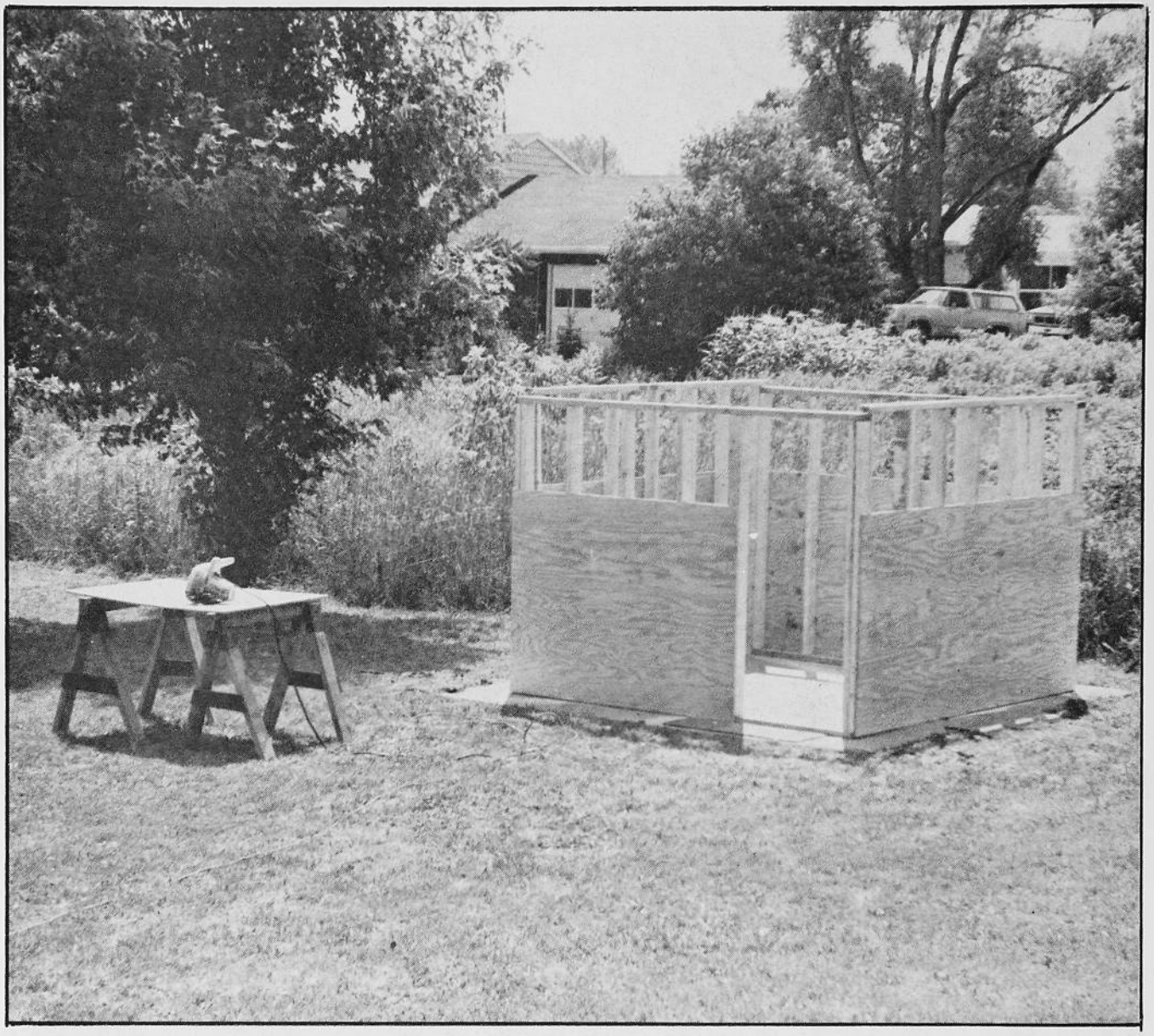
The stairway up to the observatory is 3′ wide and has 10 standard steps. It is hinged at the top step, and counterweighted with ropes from the bottom of the steps. It's easy to make the stairs go up with the use of a finger. The car can go in the garage with the steps up.

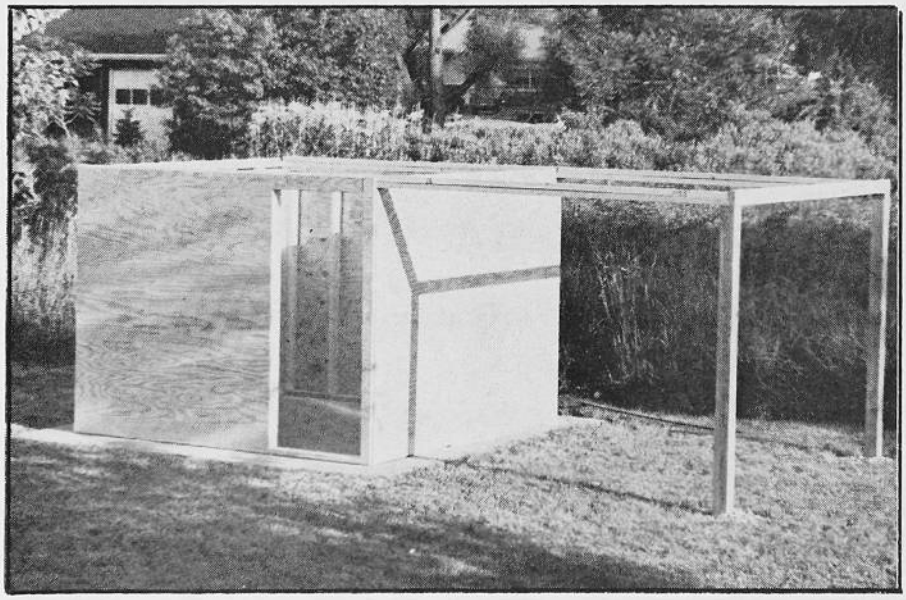
The dome cost about $200.00. The cost of changing the roof and building the room was less than $150.00. Because of the pleasure I had building the observatory, I cannot put a price on the man-hours worked (about 100 hours). This is the second dome I've built in the last five years, and it's made my observing mosquito-free. This observatory has now been in use for five years and has survived our Ohio weather.

Ronald B. McDaniel
1558 Eastwood Ave.
Akron, OH

Mr. McDaniel adds that he has considered marketing this observatory in kit form as an inexpensive help for other amateurs. He adds, however, that he needs feedback from those in other states to see if it would sell.







Rolling Ridge Observatory

Upon completion of my 8-inch f/16 Cassegrain telescope, described in TM#8, I found myself with a quality instrument with only one problem remaining: the telescope was in my basement and needed a home.

Of course, prior to construction of this telescope, I knew I needed an observatory, and had made the commitment to build one. Behind the house, there was a ten-by-ten-foot pad of concrete lying in a corner of my propety. Its original purpose had been for the

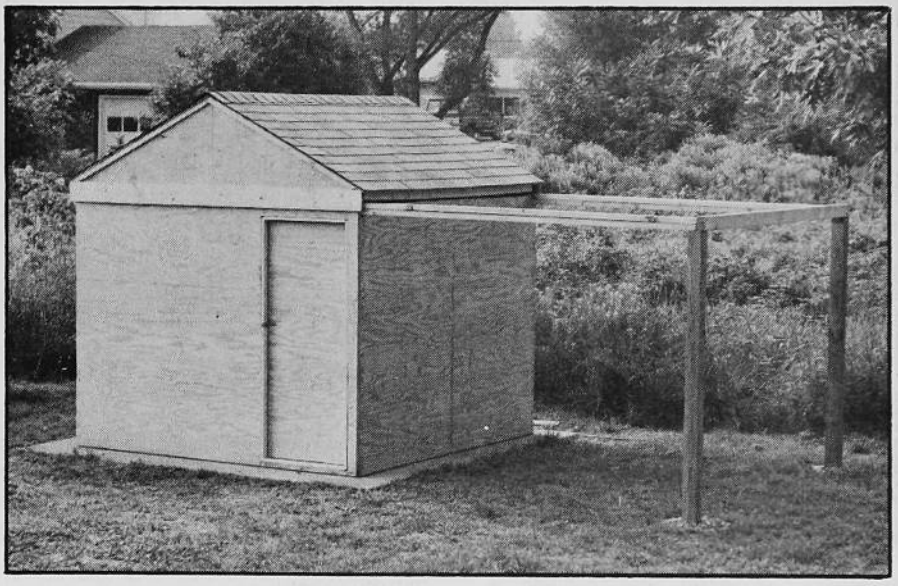
installation of one of those little metal sheds that everyone seems to have. Fortunately, before the purchase, a severe storm with very high winds came through the area. I saw several of these metal buildings moving through neighboring yards, scattering their contents, and rolling or sliding down the street. Needless to say, I abandoned all thought of purchasing a utility building and the money remained in the bank.

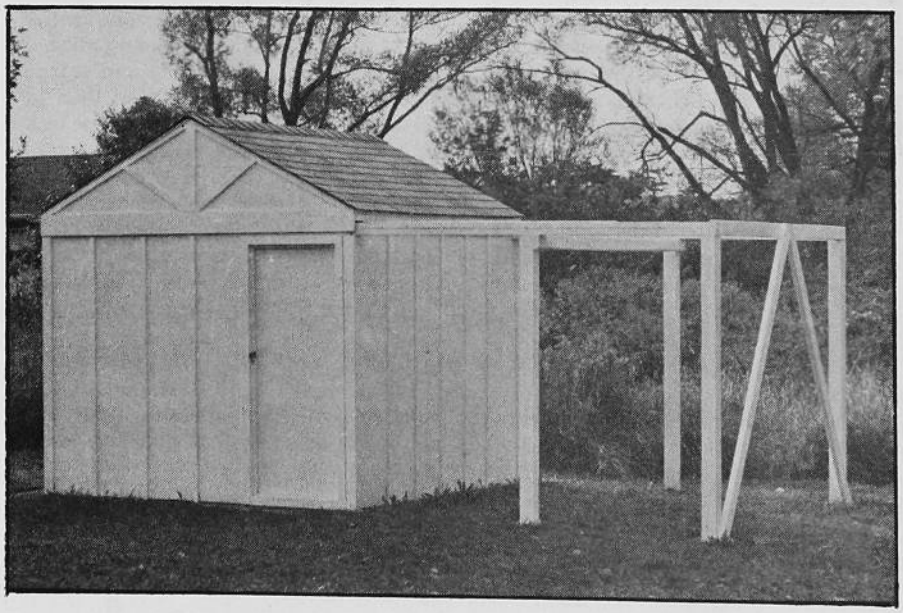
Several years later, after my entry into astronomy (and unbeknownst to my wife), I had a use for this vacant pad of concrete — a permanent observatory, a place I could go on a clear night, unlock the door, and in moments be viewing the heavens. The cumbersome task of lugging in and out a heavy Newtonian with accessories would finally be a thing of the past!

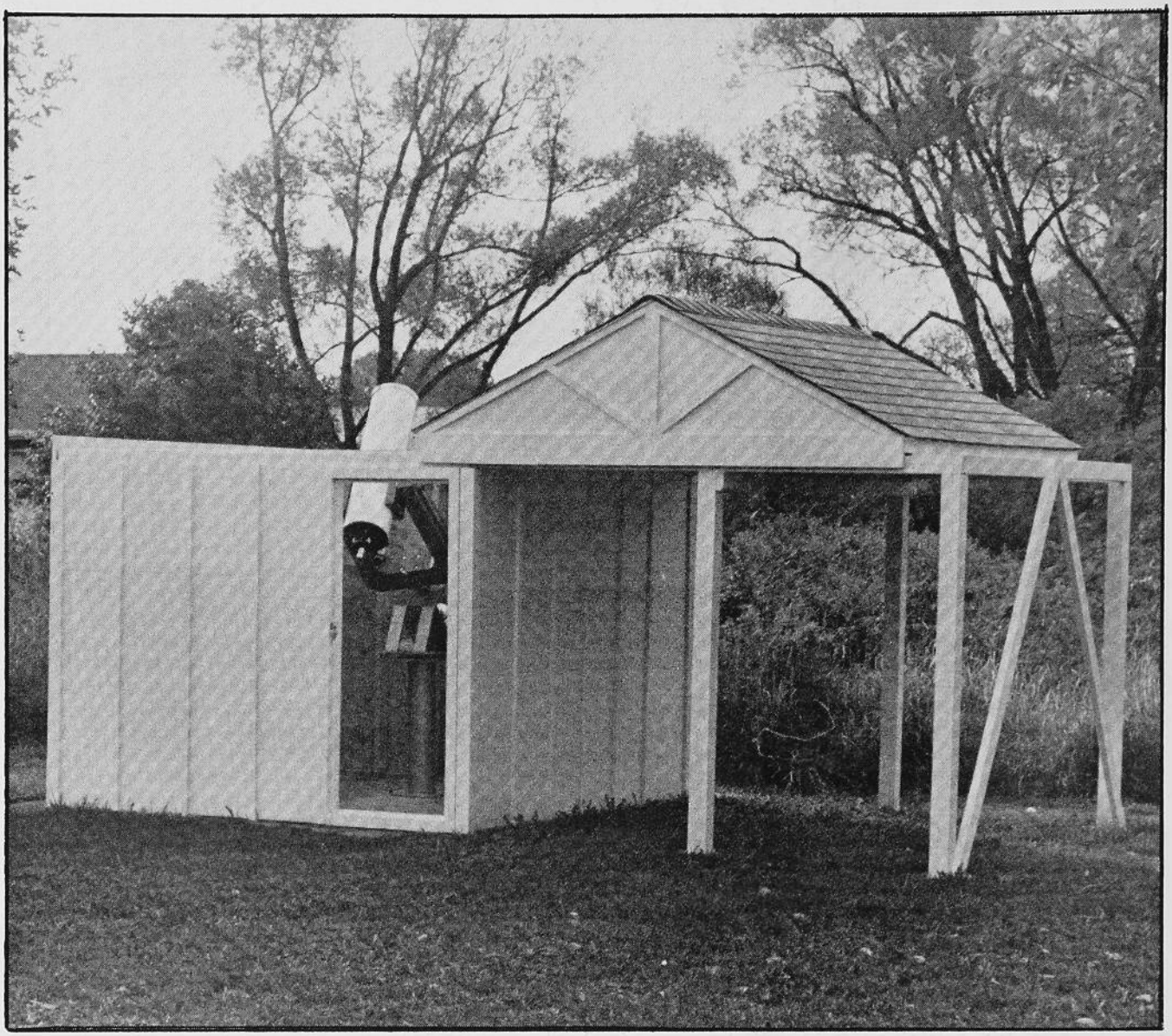
At the start, I considered several telescope designs. I'd used a small refractor and several Newtonians, but finally selected the classical Cassegrain for the observatory. Besides its long focal length, this choice allowed me to construct high observatory walls to serve as windbreaks and provide protection for winter observing. Using the resultant telescope dimensions along with the restricting size of the concrete pad, I determined the size of the observatory, and the plans began to take shape in my mind.

For years I have carefully read and studied every article I could find on amateur observatories. I considered the pros and cons of various building styles from rotating buildings to rotating domes, from lift-off roofs to sliding roofs — each was evaluated. They all have advantages, and they all have disadvantages. The sliding roof design, however, had several important features that attracted me:

- The design is simple and straightforward. No exceptional carpentry skills are necessary.
- It is economical. Two-by-four construction, plywood, several four-by-fours of treated lumber, and some sturdy wheels are all the materials required. (Rotating buildings or domes which try carpentry skills also require a heavy fabricated or rolled ring as a major component, and unless you have access to a weld shop or decent junk yard, you could end up spending a few bucks on this item.)
- It does not call attention to itself. I doubt if several of my immediate neighbors know the reason for the building. When I explained the function of the building to one, he exclaimed that he thought it was only a storage building and that the outriggers and crosspieces were for hanging plants. (Take that, you vandals!)
- The high walls are a convenience







with a Cassegrain and provide a windbreak. Even on mild evenings, just a hint of breeze can become bone-chilling when you're standing out in the open.

• Most important, with the roof rolled back, you have an unobstructed view of the sky. For this amateur, who respects his lack of knowledge of the sky and is not yet proficient or intensely involved with one field of concentration, the view through a narrow slit could not satisfy.

With the concept in my head, immediate work was begun on the design of the observatory. Cost estimates were made. I think it's important that, when a project such as this is undertaken, you set your goals and establish a budget, especially in these days of inflation and rapidly changing prices. (You will become very aware of the price fluctuations of a two-by-four or a sheet of plywood.) The total cost of this building, excluding concrete and electricals, amounted to $250 — the price of the mirrors alone!

After completing sketches of the building, I assembled the frames for the walls and stored them in my garage. I purchased materials slowly and stored them until vacation time arrived, then, in one morning in late July, the frame was quickly installed and the plywood exterior easily fitted into place. The photographs show how construction proceeded. The work is straightforward, and I used only tools available to most households. Though I have a table saw and a portable power saw, all other tools were hand tools.

On August 25, 1979, the 8-inch Cassegrain parts were carried to the observatory and mounted in place. As darkness fell, the roof-retaining bolts were removed and the roof rolled back. Pointing the scope toward Altair — first light!

Since that day of first light, the observatory has been used as often as I have clear skies here along the shore of Lake Erie. The view of the planets and stars that I've observed shows the 8-inch Cassegrain to be a good performer.

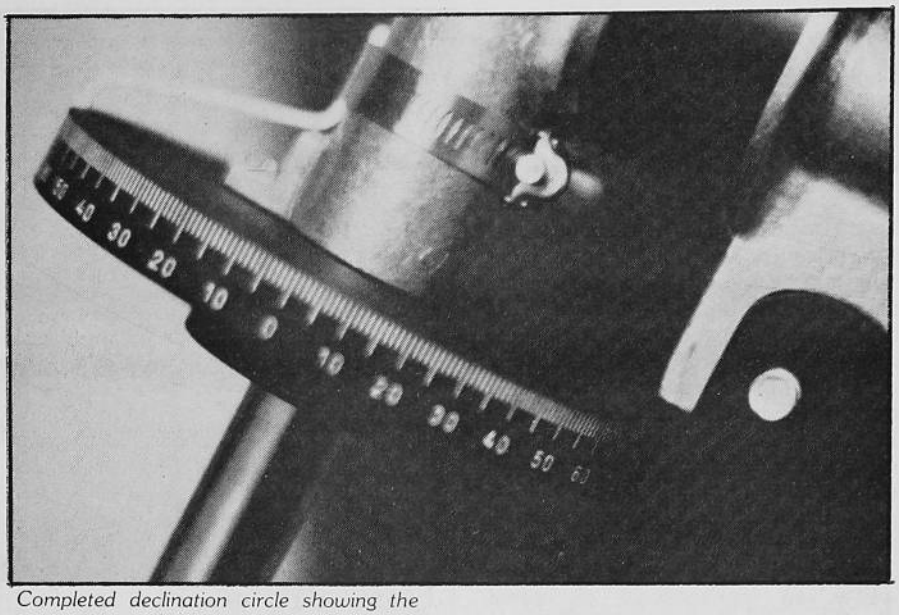
The building, though functional, is not yet completed. Power has yet to be run to the observatory — which will eliminate the hundred-foot extension cord for the telescope drive. But on most clear nights, I'm content to just roll back the roof, view the planets, look for Messier objects, split double stars, and just generally enjoy the heavens.

As time passes and my experience grows, I'll try new ideas to improve upon my observatory. The hours of planning a project like this can be as satisfying as the hours of use, not to mention the satisfaction of saying, "I built it myself."

Robert C. Reisenweber
3621 Ridge Parkway
Erie, PA 16510

■

Installing Bigger Circles on a Commercial Mount



Completed declination circle showing the temporary coathanger pointer.

For supporting my 8″ f/4-f/15 Newtonian-Cassegrain telescope, I purchased a Meade model 853 equatorial mount. However, a weak link in the system was the 3″ diameter of the setting circles supplied with the mount. They simply weren't sufficient for trying to locate objects with the telescope used in its f/15. I modified the mounting in approximately four hours to use a set of Star 6″ plastic setting circles, doubling the accuracy with which the scope can be set.

The changes to the mounting involved the following:

Declination Circle

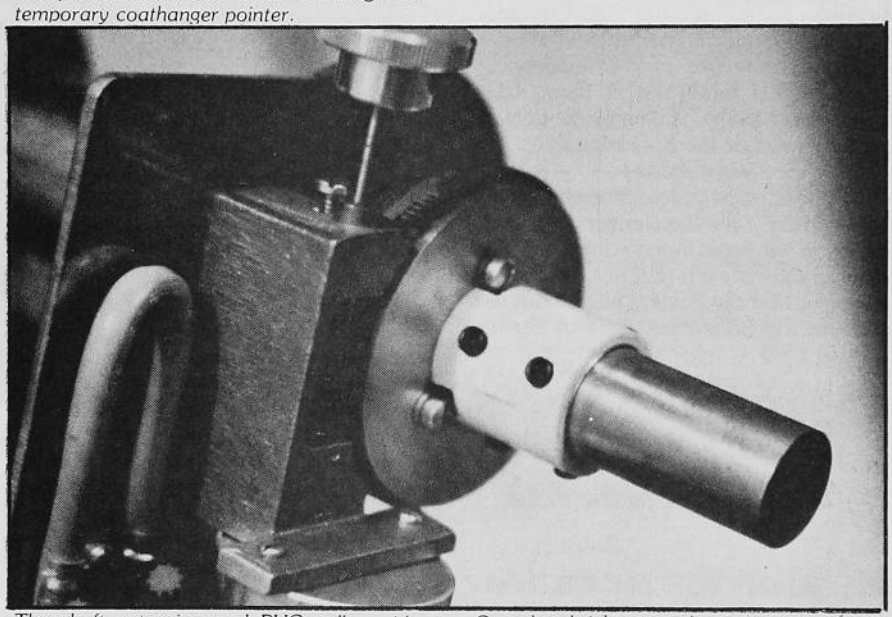
Approximately 1/3″ of the equatorial mount support had to be trimmed off to provide enough clearance with the new circle. I did the rough cutting with a hacksaw and the fine finishing with a belt sander. No modifications to the declination shaft or setting circle were required. I made a temporary pointer from a piece of coathanger attached to the mount with a hose clamp, then later designed a permanent pointer and fabricated it from ⅛″ aluminum. (It was epoxied to the base of the declination shaft housing after the slides were taken, but the photo shows its shape for those desiring to construct one.)

Right Ascension Circle

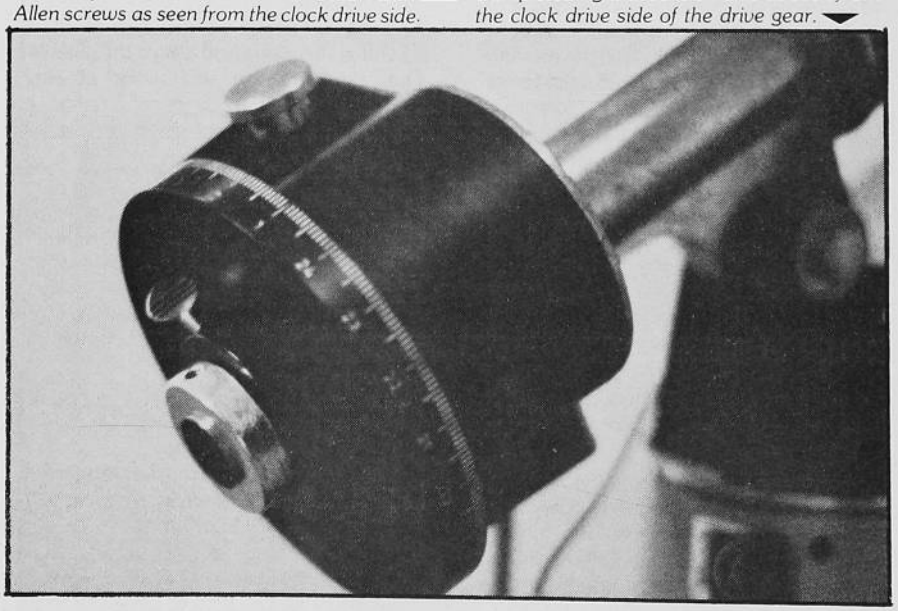
The motor dust cover had to be removed, and a 1¼″ hole drilled through the plastic to allow for the extension of the right ascension shaft. A 2½″ piece of 1″ O.D. brass toilet tank overflow tube was coupled to the end of the steel polar shaft using a PVC water pipe coupler, metallic duct tape, and six Allen screws. I scribed a mark on the back of the motor dust cover, and painted it with white paint to form a pointer.

Jack Huerkamp
20 N. Blueridge Ct.
New Orleans, LA 70128

■



The shaft extension and PVC collar with Allen screws as seen from the clock drive side.



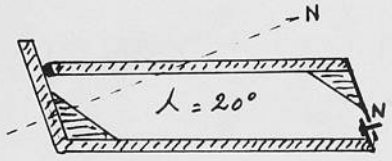
Completed right ascension axis as seen from the clock drive side of the drive gear.

PONCET on the PONCET

Many variations are possible on the basic Poncet equatorial table, permitting the device to work effectively at a wider range of latitudes than the design described by Robert Cox in TM#8. In thinking of the Poncet mount, you must remember that the guiding plane determines the axis of rotation, but that the pivot point can be placed anywhere in space — north, south, east, or west, over, under, or even in the plane. (The choice of the location is determined primarily by the balance and stability of the structure.) In some forms, the Poncet mount functionally resembles well-known "conventional" equatorial designs such as that of Thomas Dessert's equatorial described in TM#5. The small one-arm fork catadioptrics also use this form, but in them, ball bearings act as the guiding plane. Let us explore some of the possibilities.

Mid-latitudes

For medium latitudes, those between 35° and 65°, the conventional design shown in two sizes in the accompanying photographs is most practical. In these, the pivot and the guiding plane both lie close to the horizontal plane of Earth.



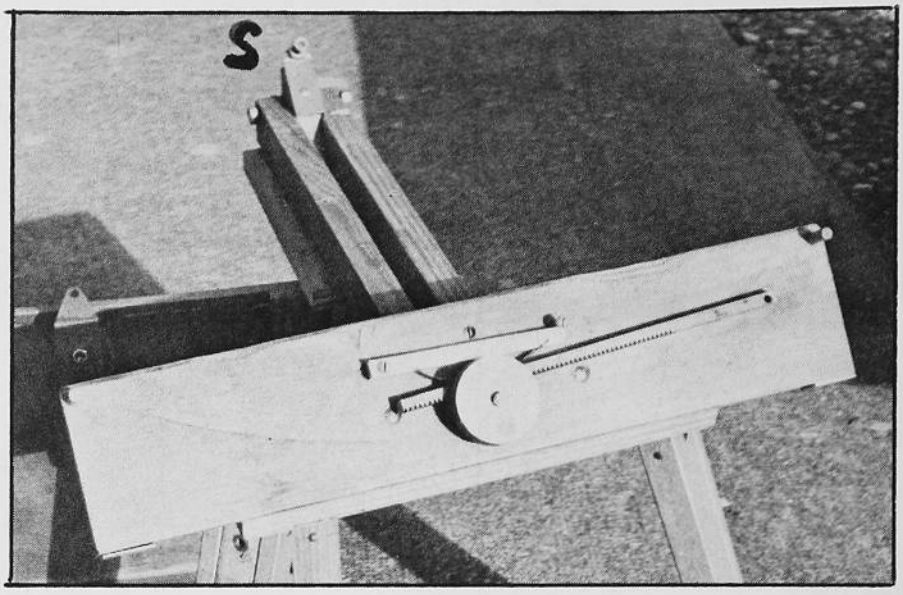
Both devices allow agreeable hand tracking for up to an hour. The larger one (40 centimeters square) uses a rack and pinion, and is shown without the table in place. The rack is attached to the moving table and is held against the 20-tooth pinion gear by a leaf spring.

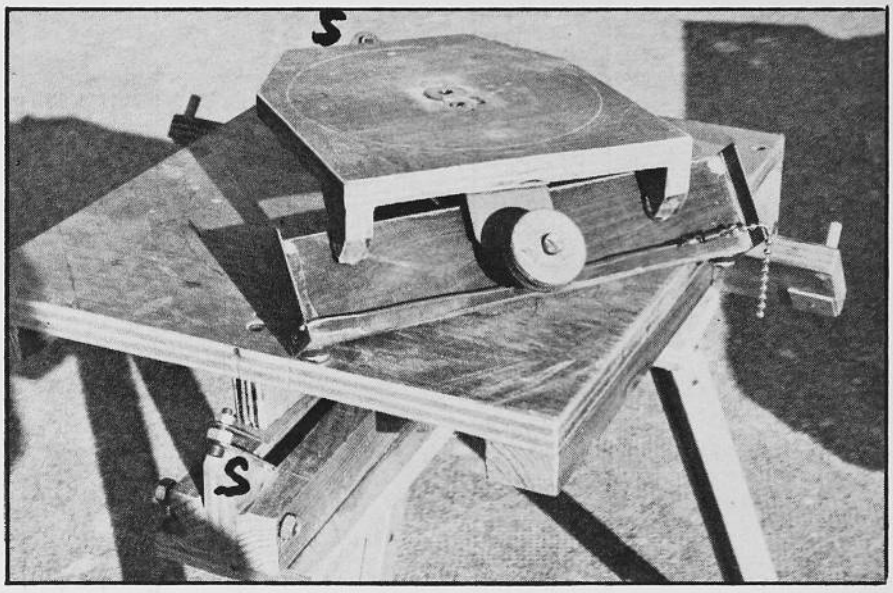
The smaller table (20 centimeters square), shown on top of the larger one, is driven by turning a pulley knob attached to the table. A steel cable, held taut by a strong spring, wraps around the pulley. The ball chain allows quick adjustment of the tension on the cable.

The gliders on both tables are chromium plated spherical surfaces sliding directly on waxed plywood. In my opinion, there is nothing better.

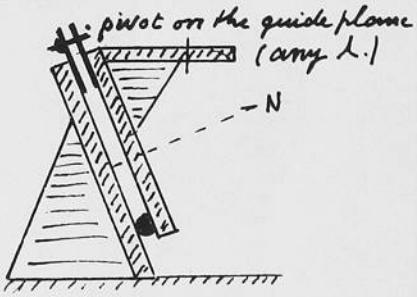
Tropical Latitudes

Between 15° and 35°, the equatorial table shown in the drawing features should solve the problem. In this scheme, the pivot is north of the guiding plane and as low as possible. Note that it will remain steady when loaded.





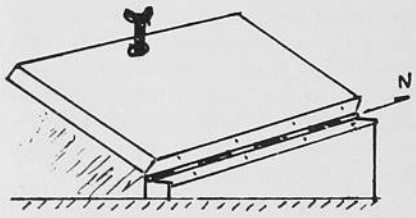
In an alternate design, the pivot is placed in the plane and above the gliders. This configuration will work at any



latitude, but I've avoided it because the structure is not compact.

Equatorial Latitudes

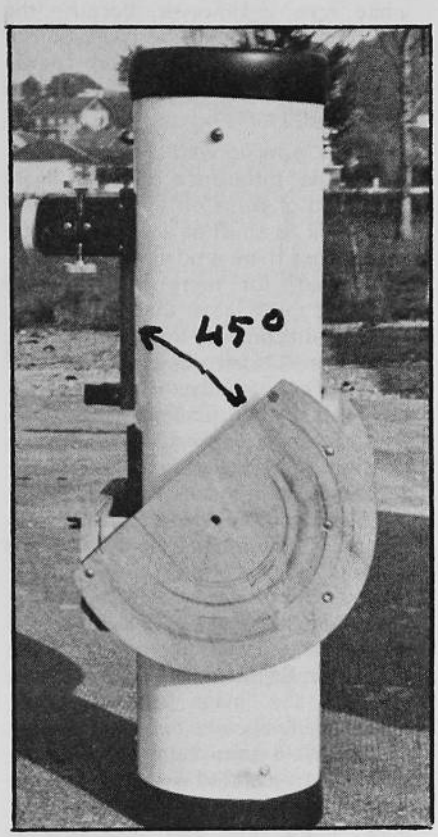
Within 15° of the equator, the equatorial axis is nearly horizontal. Here,



I must surrender to my Scotch friend George Haig's hinge equatorial described in TM#7. This is a very simple and easy equatorial table and one plane can even be replaced by the ground.

Polar Latitudes

Near the pole, the polar axis is close to vertical, and any alt-azimuth mounting is equatorial and can track for 24 hours. Again, the pivot for the motion of the table need not be at the center of the guide plane even though it is most efficient to place it there.



A Simple Azimuthal Mount

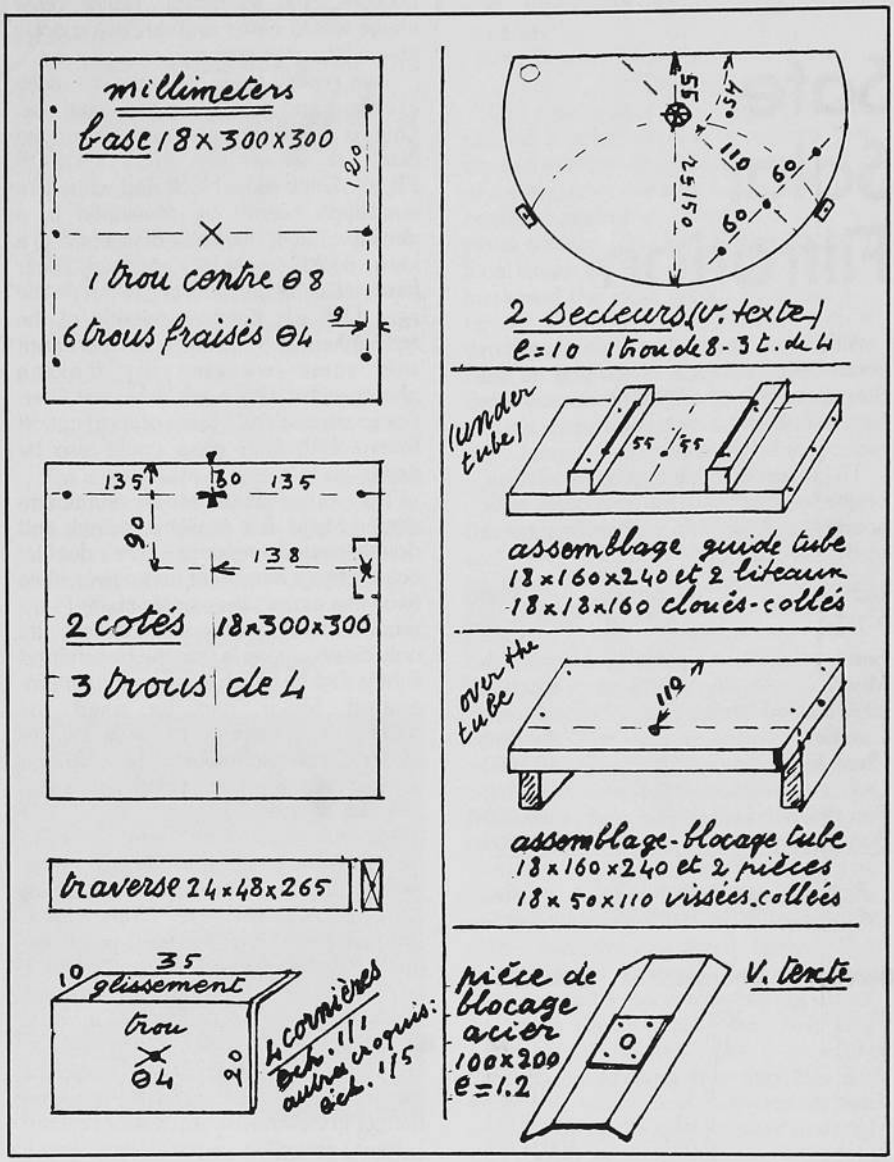
For small aperture telescopes of short focal length, the Dobsonian mount may be too low for comfortable use. This azimuthal mounting built for a 6-inch f/5 telescope, while not a Dobsonian, performs much the same way. This design allows me to use my original telescope unaltered, even though it would be easier if the tube were square.

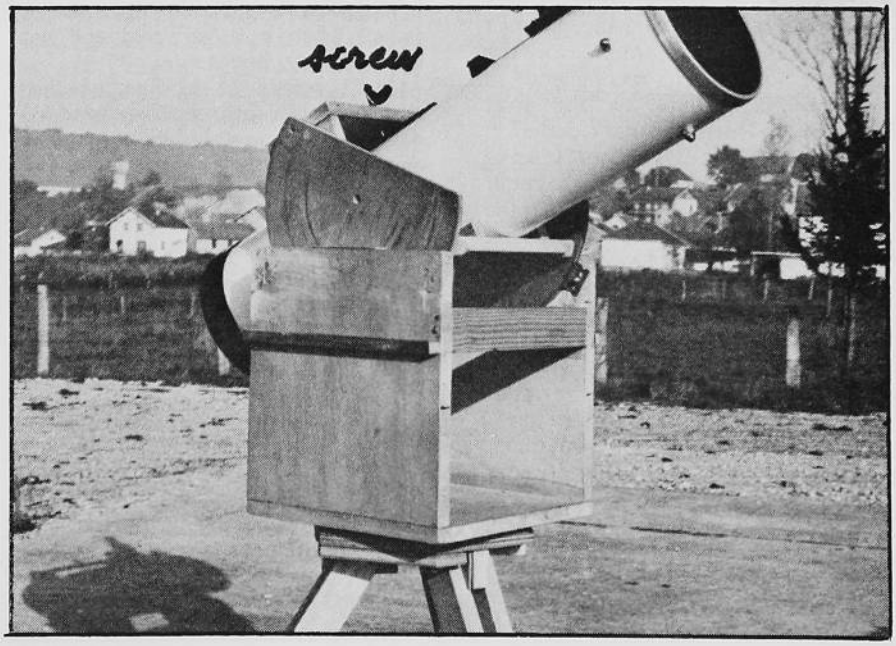
Plans for the mounting show all dimensions suitable for a 6-inch f/5 reflector, but would be suitable for 8-inch telescopes if enlarged 1.5 times, and for a 10-inch by doubling them. The material is plywood, and I think that a 1" thickness is quite sufficient for the box, with ½" used for the trunnions.

After many experiments, I found the best gliders to be polished steel on the waxed edge of the plywood. The gliders are attached to a small piece of steel angle which before being bolted down, should be allowed to take an isostatic position against the plywood.

The tube is held by only one hand screw that presses against the bent piece of steel resting on the tube. I can slide the tube back and forth for balance and rotate it to any angle before tightening this screw.

Adrien Poncet
7, Boul de la Republique
St-Claude, Jura
France





Safe Solar Filtration

Although much has been written about safe methods of looking at the Sun, especially at eclipse time, no article has described the wide variety of ways to reduce its brightness.

The following table shows the intrinsic brightness of several common light sources and the ratio of their brightness to that of the Sun:

Light Source	Brightness Cd/cm²	Ratio Sun/Source
Sun	160,000	1
Moon	0.25	640,000
40W frosted lamp	2.5	64,000
Candle	0.6	267,000
Clear Sky	0.4	400,000
Overcast Sky	0.5	320,000
Sun through D=5	1.6	100,000
Sun through D=6	0.16	1,000,000

Another very useful table is the reduction ratio for neutral density filters:

Density	%Transmission	Reduction
0	100	1:1
1	10	10:1
2	1	100:1
3	0.1	1000:1
4	0.01	10,000:1
5	0.001	100,000:1
6	0.0001	1,000,000:1

Eastman Kodak Company, in their "Solar-Eclipse Photography for the Amateur" pamphlet, recommends a minimum density of six for solar observation. This is quite dark, darker, in fact, than an image of the Moon. In some respects, a density of five is a better compromise since it allows viewing the Sun when there is a hazy atmosphere. However, for those in the southwestern deserts, much less than a density of six might not be fully comfortable or safe.

Direct Visual Observing

The human eye has a focal length of about 20 mm and the pupil size varies from about 2 to 8 mm. The 8 mm size is only obtained by a young person under fully dark-adapted conditions. Under bright sunlight conditions, the pupil size is about 2 mm (f/10) and the image size of the Sun on the retina is about 0.2 mm, or 200 microns. Since the diameter of a single cone in the eye is about 2.5 microns, the extremely bright solar image would cover and destroy a circle about 80 cones across.

Two readily available materials make excellent and safe filters for visual use. One is fully exposed and developed black & white film (NOT COLOR FILM). Since most black and white film emulsions cannot be developed to a density of five, two films developed to a lower density must be combined. Silver has a transmission leak at 314 nm (in the near UV) but the transmission of the atmosphere and film base cut off at about the same wavelength, making photographic film a good neutral filter. For greater safety, a piece of short cut-off (minus UV) filter glass could also be used.

The other material is aluminum-coated Mylar. It is available in single and double-coated versions. The double-coated has a density of about five, while two pieces of the single-coated are required to reach the same density. Its only disadvantage is that the transmitted light is slightly bluish in color. Aluminum-coated Mylar can be used for photography while the black and white film emulsion cannot, because scattering caused by the silver grains in the film reduces contrast.

Materials that should NOT be used because they let through excessive energy in the infrared are Eastman Kodak's Wratten #96 filters, color photographic films, ordinary polarizing filters, and some welding glass filters. Many welding filters are good, but some leak excessive amounts of infrared radiation.

Under certain atmospheric conditions such as a uniform heavy haze, there is no danger in viewing the Sun without a filter. I have viewed sunspots under such conditions with binoculars. It is also safe to look directly at the Sun at sunrise or sunset when it is very red and not uncomfortably bright.

At an eclipse of the Sun, whether partial, annular, or total, there is added danger since the pupil of the eye may be enlarged while the exposed portion of the Sun is smaller. The intrinsic brightness of the crescent is nearly undiminished.

Viewing by Image Projection

For group viewing of the Sun, projecting the solar image from the eyepiece of a telescope or even binoculars provides completely safe levels of illumination, usually not brighter than sunlight shining on a white sheet of paper. Use a shadow mask to prevent direct sunlight from shining on the solar image and diminishing its contrast.

Both refractors and reflectors up to a 6-inch aperture work very well in projecting an image of the Sun onto a white screen. However, because the heat coming through the eyepiece can soften or destroy cemented lenses, expensive eyepieces or binoculars should not be used.

Direct Viewing with a Telescope

Daytime turbulence severely limits resolution of detail on the Sun. Rarely can detail as small as 1 arc-second be seen, hence there is no need, apart from the "need" for more light, to use apertures much larger than four inches. Several attachments for observing the Sun through a telescope are described below along with the advantages and problems of each. Except for the first, these are most applicable to refractors because of the relatively long drawtube accommodation they require.

• Absorbing Filters: The 60 mm refractors imported from Japan are supplied with absorbing filters for solar observation. Some screw into the eyepiece ahead of the field lens, and others are attached externally over the eyelens. In the first instance, the filter is close to the image formed by the objective and absorbs the light and heat over a 5.6 to 8.4 mm diameter area of the filter. When installed over the eyelens, the filter is located very close to the exit pupil where the light and heat is concentrated in a very small area. Norman Sperling, of *Sky & Telescope*, has been collecting evidence in an attempt to make it illegal to supply such filters with these instruments. (I pointed one such instrument at the Sun for 30 seconds. The external absorbing filter was so hot that it could not be removed with unprotected hands. IMPORTANT: Any amateur who knows of anyone with these filters should encourage them to throw them away.)

One safe way to attenuate light is using uncoated glass surfaces as mirrors. The formulae needed to calculate the reflectance follow.

Reflectance from an uncoated glass surface depends on the index of refraction of the glass and the angle of incidence onto the surface. For normal incidence (I=0°),

$$R = (n-1)^2/(n=1)^2$$

With n = 1.517,

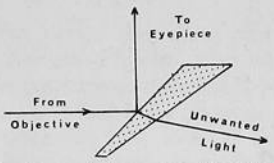
$$R = 0.042 \text{ (Density = 1.37)}$$

When the incident angle is other than 0°, the following formula must be used:

$$R = \sin^2(I-I')/2\sin^2(I+I') + \tan^2(I+I')/2\tan^2(I+I')$$

where $\sin I' = \sin I/n$

• Herschel Wedge: This well-known device consists of a small-angle prism installed ahead of the eyepiece at a 45° angle. It resembles a zenith prism attachment except that both surfaces are uncoated. The angle of the prism eliminates the second surface reflection.



For the Herschel wedge, the incident angle, I, is 45°. Assuming n=1.517, then I′=27.7828°, (I-I′)=17.2172°, and (I+I′)=72.7828°.

$$R = \sin^2 17.2172°/2\sin^2 72.7828° + \tan^2 17.2172°/2\tan^2 72.7828°$$
$$R = .04801+.00461=.0526$$

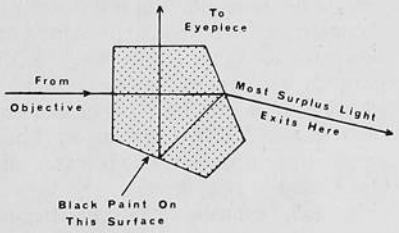
Since 5.3% of the light is reflected to the eyepiece, it acts like a 1.28 density filter. Because of this, heavy absorbing filters are still needed to reduce the brightness of the image. Usually at least two separate filters are used, since they can shatter when used with larger aperture instruments.

• Unsilvered Pentaprism: Pentaprisms, readily available surplus, have two reflecting surfaces coated with silver. By stripping the silver from these surfaces, you effectively have a double Herschel wedge.

Here the incident angle is 22.5°. Assuming n=1.517 and I′=35.4879°, (I-I′)=12.9879°, and (I+I′)= 57.9870°; then:

$$R = \sin^2 12.9879°/2\sin^2 57.9879° + \tan^2 12.9879°/2\tan^2 57.9879°$$
$$R = .03513+.01040=.04553.$$

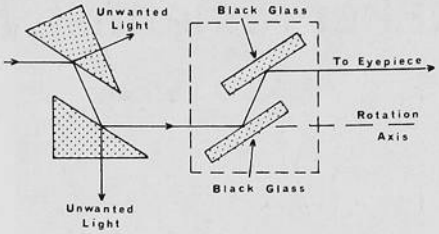
The density of one reflection is 1.34; the density of two reflections is 2.68. The pentaprism also turns the light path 90° but with no inversion of the image. It is helpful in improving contrast to paint the bottom surface with a black lacquer.



By lacquering the surfaces, the density can be raised to five or more. Furthermore, since the light is substantially polarized by the two reflections, a single sheet of polaroid film can be rotated to adjust the brightness.

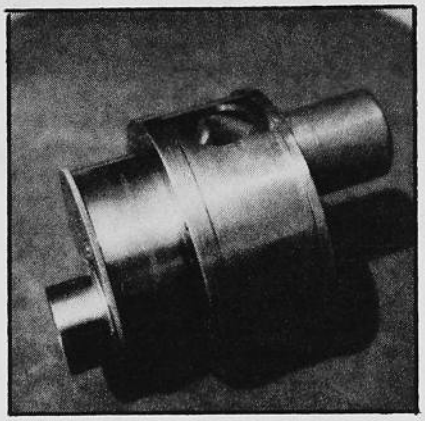
• Liquid-backed Zenith Prism: This method is described by J. R. Haviland in his article on refractors in *Amateur Telescope Making - Book II*, pages 258 and 259. He suggests mounting a right-angle prism in a watertight box so that a liquid can be brought into contact with the hypotenuse face. By using an oil with an index of refraction close to that of the prism, the reflection from the hypotenuse face can be reduced substantially. Over and above the oily mess problem, however, the index of refraction of oils changes substantially with temperature, posing some problems.

• Polarizing Mirror Attachment: This very elegant method used by professional astronomers employs four uncoated mirrors mounted at Brewster's angle.



For a glass with an index of refraction of 1.517, Brewster's angle is 56.6073°. At this incidence angle, the light is 100% polarized and the transmission, assuming n=1.517, I′=33.3927°, (I-I′)=23.2146°, and (I+I′)=90°, is:

$$R = \sin^2 23.2146°/2\sin^2 90° + \tan^2 23.2146°/2\tan^2 90°$$
$$R = .07769+0.0=.07769.$$



The equivalent density is 1.11 for each reflection. By rotating two of the mirrors with respect to the other two, the light intensity can be reduced to any desired amount. One such unit, made by John A. Brashear, Allegheny, PA, consists of two clear prisms with angles of 33.39° and two plates of black glass. It works very well with f/15 refractors, providing a very neutral image, but would be a very expensive device to manufacture.

Reflectors with Uncoated Optics

A reflecting telescope with uncoated mirrors works quite successfully for solar observation. The reflectance from the concave mirror is approximately .042 (Density = 1.37). That for the diagonal mirror will be .05262 (Density = 1.28), for a total effective density of 2.65. An eyepiece filter with a density of about 2.35 is still needed. The diagonal mirror should be a wedge (like the Herschel wedge) or the back surface ground and lacquered black to eliminate the second surface reflection. The back of the primary mirror should also be ground and blackened to improve image contrast.

Attachments for Reflectors and Refractors

Criterion Scientific Instruments offered a solar viewing accessory that slipped into the eyepiece tube consisting of a plano-concave lens with a reflecting coating, probably aluminum, on the plano surface. This lens, a Barlow, had a focal length of -74 mm and, like a Barlow, increased the focal length by about 1.7 times. The reflecting coating had a density of about 1.54 and a separate neutral absorbing filter increased the density to about 5.5. It was a convenient and inexpensive attachment. I believe it is no longer available.

External Reflecting Filters

The best place for a sun filter is over the front of the tube. All the excess light and heat is then kept outside the instrument. Such an attachment was first offered by Questar, and later by Celestron and Criterion for their catadioptric telescopes. Since the reflecting coating is on optically polished plane-parallel glass plates, the cost is very high. The coating used is Inconel, which is very neutral in lower densities but at high densities transmits more red than blue light. Thus, the image is reddish in color.

Another readily available material is aluminum-coated Mylar film. This thin, strong plastic film is available, cheaply, in single and double-coated forms. The single-coated material requires two thicknesses to reach a density of about 5.0. With the double-coated, only one thickness is needed. There is some difficulty in keeping this thin film flat especially when two thicknesses are used, so using the single-coated material may result in some loss of definition. Aluminum-coated Mylar is a little more transparent in the blue, resulting in a slightly bluish image. It can be made nearly neutral by adding a pale yellow filter near the focal plane.

Inconel reflects about 60% and aluminum about 90% of the incident light. The remainder, to reach a density of 5.0, must be absorbed in the coating. These thin coatings obviously get warm in the process of absorbing this energy. Under high humidity conditions, dew may form on the back surface of the Mylar or the glass plate. It helps to have some air circulation behind these filters.

While these full aperture filters have been very helpful in making safe observation of the Sun available, what is still needed is a good, neutral, inexpensive coated filter on a glass plate.

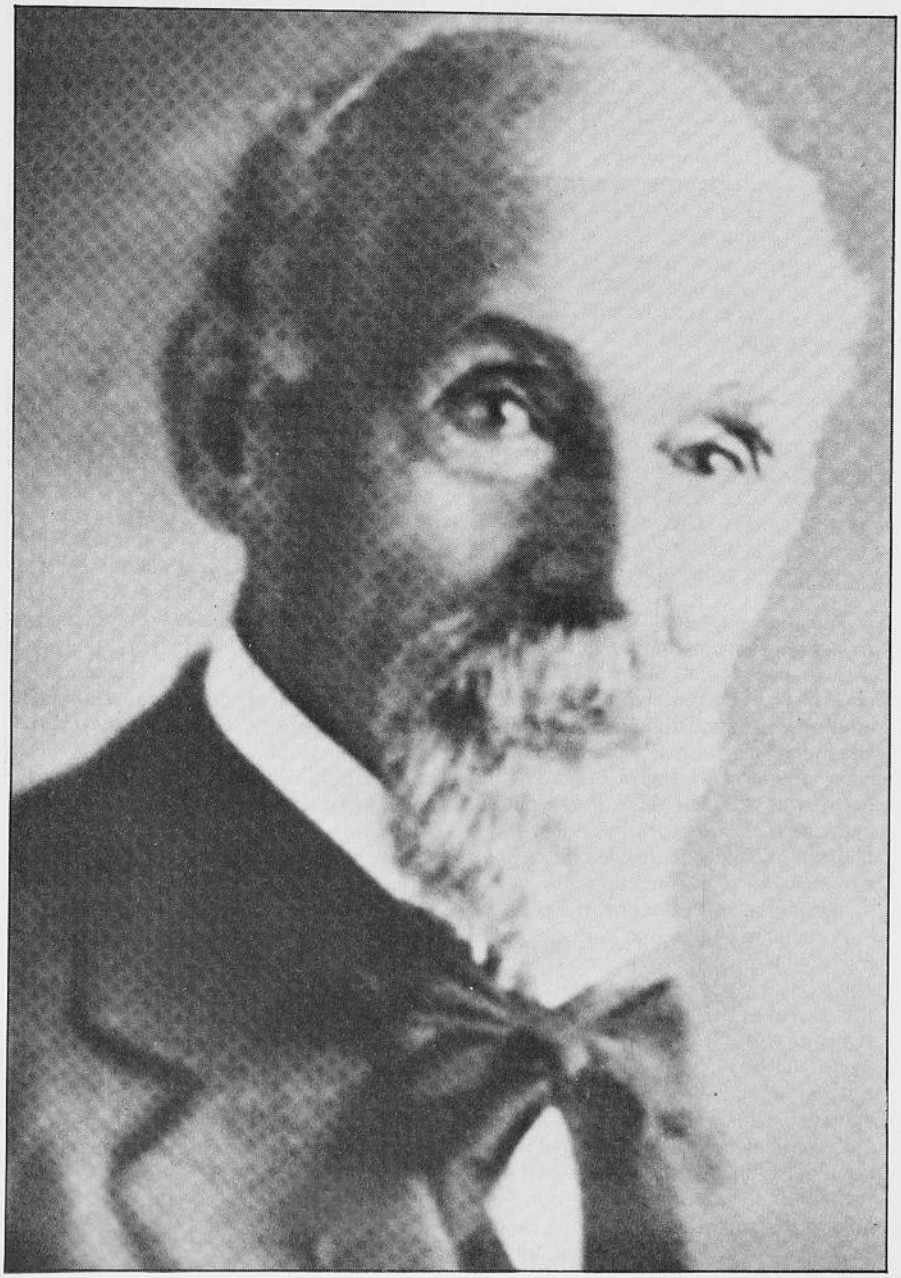
Ralph K. Dakin
720 Pittsford-Victor Rd.
Pittsford, NY 14534

■

John A. Brashear

Telescope Maker, Scientist, Humanitarian

by Mark Urbaetis



John A. Brashear

Amateur astronomers are familiar with the story of the Clarks, America's foremost telescope makers. The 40-inch Yerkes refractor stands as a working testimonial of their abilities. Of equal stature, but less well known, is John A. Brashear, responsible for the construction of several of the world's largest telescopes. His accomplishments as a telescope maker are all the more remarkable in that the majority of his optical work was accomplished after he had turned 50.

John Brashear was born in 1840 in Brownsville, Pennsylvania, located about 60 miles south of Pittsburgh. His maternal grandfather, Nathaniel Smith, instilled an early interest in astronomy with his stories about the constellations and by his recounting of the passage of the great comet of 1843 and the meteoric display of 1833. The young Brashear also gained an early appreciation of mechnical devices from his grandfather who traveled from house to house repairing clocks, watches, and machinery of all types.

In 1855, he finished school and began a series of jobs as a "printers devil" and an auctioneer's helper. He soon tired of these jobs and began an apprenticeship in patternmaking for a company involved in steamboat construction. Upon completion of his apprenticeship, he accepted a position in Kentucky and was there when the Civil War broke out. The war caused his job to be suspended and he forced himself to work as a coffinmaker to earn enough money to return home. Eventually he found work in the North as a millwright in a large iron mill. This work was exceedingly exhausting and quite dangerous: the extreme heat in the mill created an ever-present fire hazard. More than once, a mill was lost to fire or explosion. It was

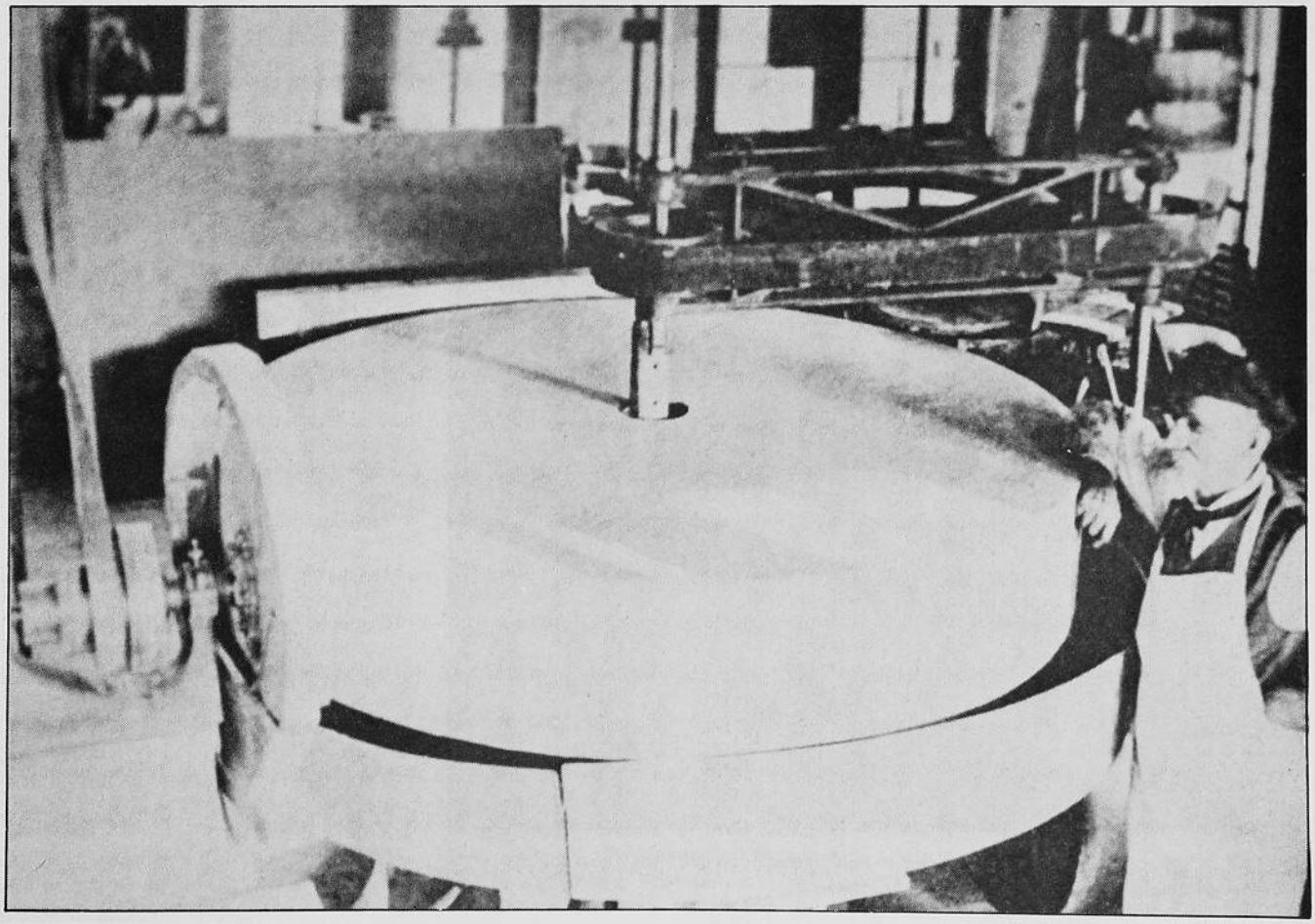
during this period that John met and married his wife Phoebe, who was to provide encouragement for his hobby of astronomy and telescope making.

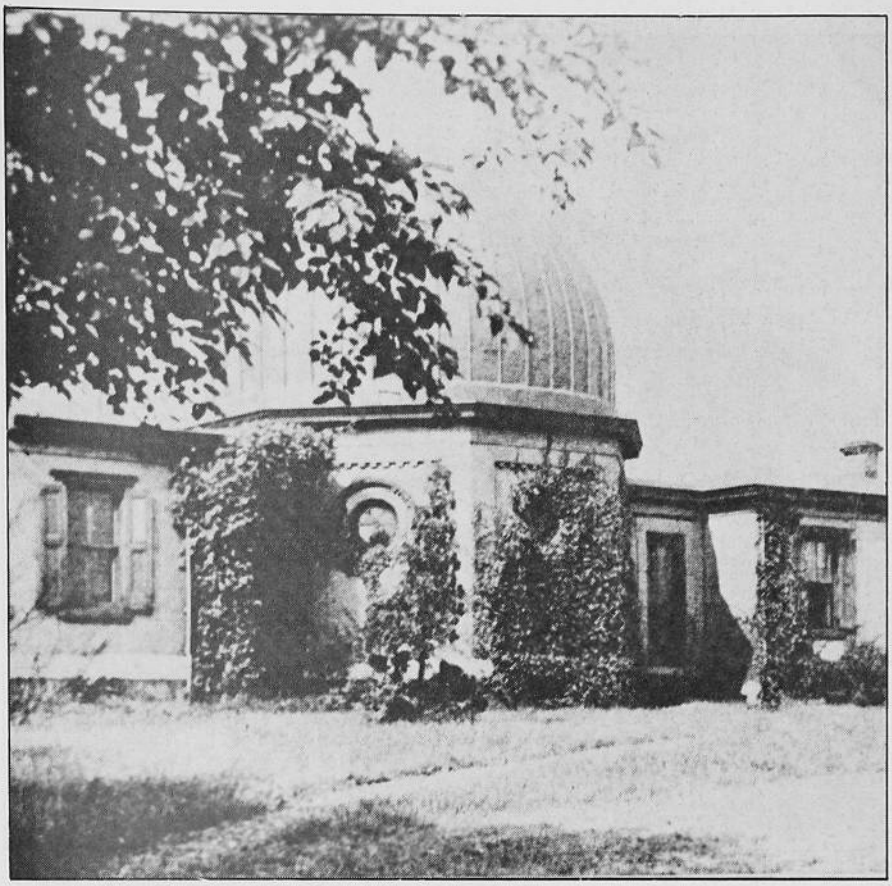
Ever since his first look at Saturn through a 2½-inch refractor, Brashear had wanted a telescope of his own. In 1872, after completing his new home, he decided to construct a 5-inch refractor. He often worked on his project until two in the morning in spite of the fact that his job required him to be up at 5:30. Throughout his long life, Brashear exhibited a characteristic ability to work long hours at exhausting tasks. His first lens required reworking several times due to scratches caused by poor abrasives. Then, just before it was finished, the crown glass of the two-element objective was dropped. Discouraged, Brashear finally completed the lens and installed the objective in a mounting of his own design and construction.

In 1876 he (in his words) "plucked up enough courage to write to Professor Samuel Pierpont Langley, who had charge of the Allegheny Observatory, asking permission to bring the objective glass to the Observatory that [Langley] might inspect it and perhaps give me

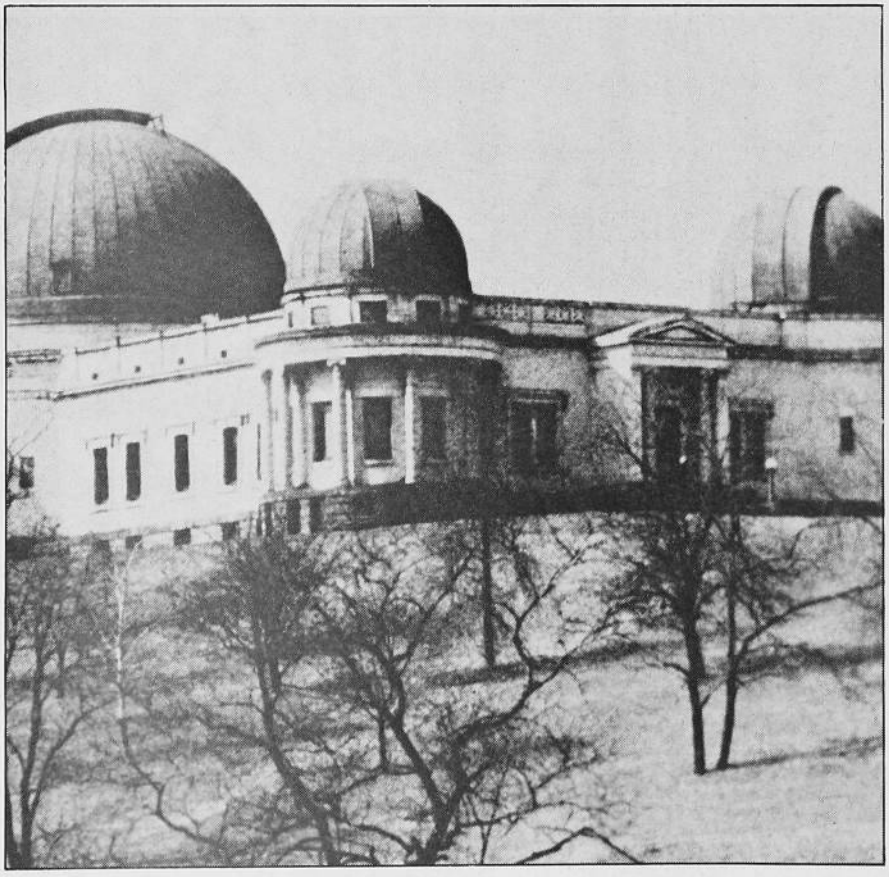
Brashear's first optical shop, 1913.

Roughing the 72" D.A.O. primary, 1915.





The Old Allegheny Observatory



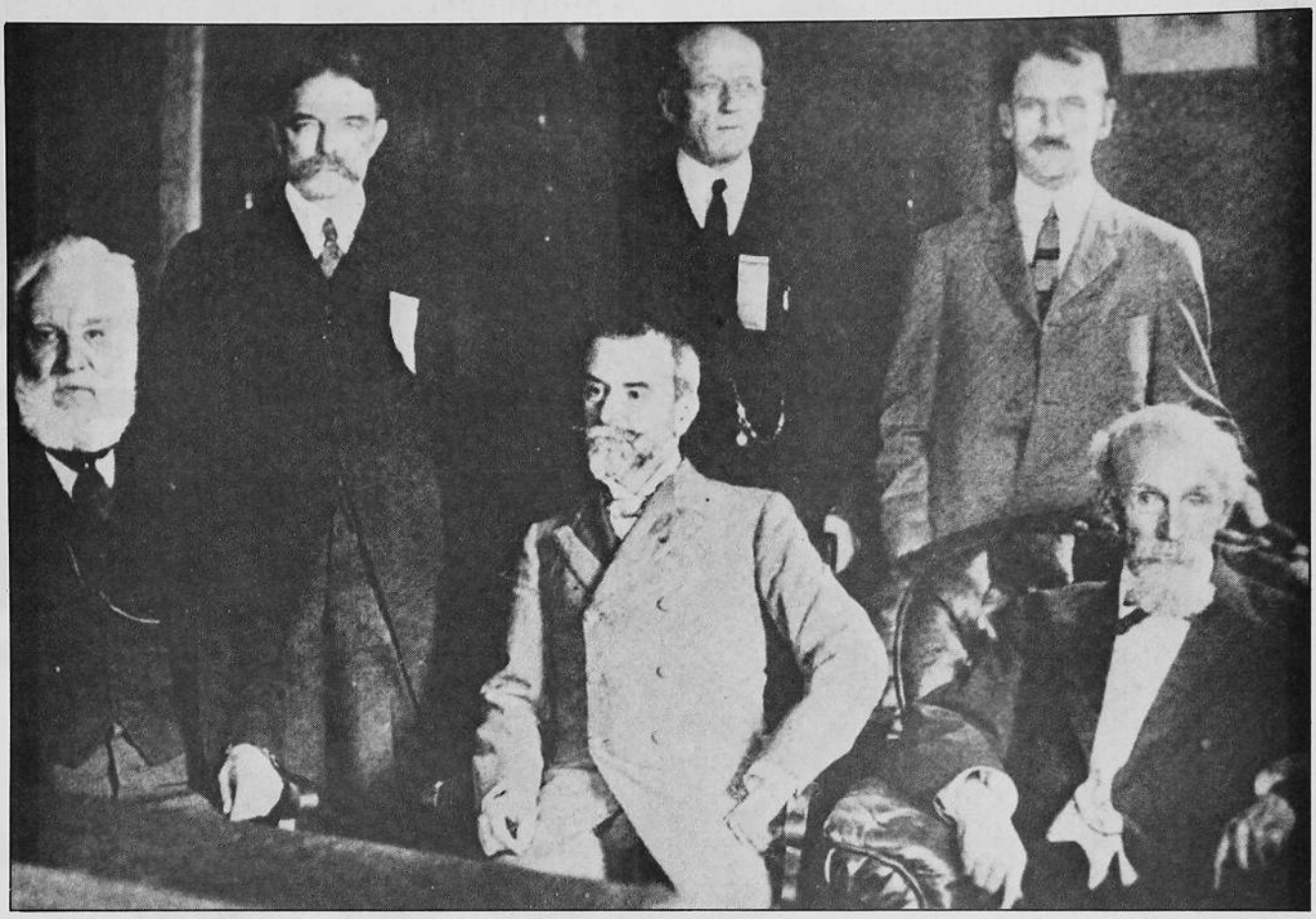
The new Allegheny Observatory. Domes, left to right, contain the 30" Thaw refractor, the public 13" refractor, and the Keeler Memorial 30" reflector.

advice about further improving it." The meeting with Langley fertilized the growing interest: Langley provided him with a book by Dr. Draper on building reflecting telescopes and encouraged him to try his hand at this as it might prove easier to construct. His first mirror was a 12-inch and it unfortunately cracked in the silvering process. This led Brashear to developing a new silvering process now known as the "Brashear Process." It was used until the 1930s, when John Strong developed vacuum aluminizing.

Brashear tried again, and his second mirror proved successful. Before long he had a steady stream of people coming to his house to observe through the telescope. He never turned anyone away, and he derived great pleasure in pointing out the sky to anyone interested. He began to contribute articles to local newspapers and even spent his lunch time at the mill talking to his fellow workers about astronomy. Before long he and Phoebe decided to go into the business of lens making as John had been doing optical work for Dr. Langley and felt encouraged enough to try it as a business. His first advertisement in *Scientific American* brought in several hundred orders and his first physical collapse. The doctor warned him that he could not work as both a millwright and an optical craftsman but must give one job up. With his son-in-law, John took up the full-time job of producing optical elements.

A chance meeting while at Allegheny Observatory provided Brashear with an unexpected assist. While delivering a mirror to Dr. Langley, John was introduced to William Thaw, one of the few men who had both an interest in science and the money needed to promote that interest. He saw the need that Brashear was filling and decided to provide the capital necessary to build the optical shops that were so sorely needed. The money was an outright gift — not charity — to allow the work to continue without worry of money. Thaw was to provide this assistance time and again when larger and still larger shops were required.

During this busy time Brashear began to provide the optical flats upon which Henry A. Rowland produced his diffraction gratings. One story told by Brashear provides an interesting look at the personalities of both men. Brashear had been supplying the plane surfaces for some time when he received a letter from Rowland stating that all of the flats recently shipped had a uniform depression in the center. Disturbed that a less than perfect set of flats had been made, Brashear left at once for Baltimore. Upon Brashear's arrival, Rowland showed him the error in the



Left to right: A.G. Bell, Gen. James Allen, Ambassador Jusseraud, Dr. Charles Walcott, Glen Curtiss, and John Brashear.

plates. An associate of Rowland, Charles S. Hastings, suggested that perhaps the test plate was in error. Rowland immediately replied, "No, Steinheil makes the best planes in the world."

However, the mate to the test plate was produced and the two planes placed together. The error was doubled! In Brashear's words: "Rowland took it all back." From that time onward Rowland never tested another plate produced by the Brashear Company.

As the fame of the work of Brashear grew, many difficult jobs came into the shop. Brashear undertook the construction of rock-salt prisms which deteriorated badly upon exposure to the slightest moisture. Soon he had devised a new method of polishing the recalcitrant material, and in due time the Brashear Co. was making the finest rock-salt prisms in the world. While perfecting his method of polishing these prisms, Langley contacted the Clarks in the hope that they might be able to produce the prisms. After building the first one, the Clark Co. refused to supply any others. The Brashear Company had the unusual combination of ability and financial backing that allowed them to construct optical components without concern for making a profit on every project.

Orders for mirrors and lenses continued to pour in. Among others was a 12-inch objective for the Dudley Observatory in Albany, New York. The lens replaced an earlier one by Henry Fitz of New York City that was less than perfect. The largest objective lens made by the Brashear Co. was for the Thaw Memorial Telescope and was of 30-inch clear aperture. Satisfactory disks of glass had be ordered from Europe and required a patient wait of 17 years.

In 1913 the company was contracted to provide the optical parts for the 72-inch reflecting telescope of the Dominion Observatory at Victoria, British Columbia. At that time it was the second largest in the world, exceeded only by the 100-inch on Mount Wilson. Although Brashear was 74, he entered into this new task with the same interest he had shown constructing his first lens. The Brashear Company also constructed a number of spectroscopes of high quality. The United States Naval Observatory purchased one, as did the Lowell Observatory at Flagstaff, Arizona.

It would be misleading to remember John Brashear only for his optical work, for although he was a superb craftsman, he was equally a humanitarian. He never lost touch with the people he left behind, but considered himself a "greasy millwright" who made good. He was concerned with the education of the poor, and could be found contributing his energies to nearly any worthwhile public cause that crossed his way.

Brashear also achieved fame in the academic world. From 1898 to 1900, he was acting director of The Allegheny Observatory while a search for a permanent director was made. From 1901-1904 he served as Acting Chancellor of Western University of Pennsylvania — a considerable honor for a man who never attended college. The students of the University as well as many of his younger friends came to affectionately know him as "Uncle John." His office was always open to anyone who wanted his advice. By the end of his life he had received six honorary degrees from colleges, including one from Princeton University, and he was made honorary member of the Alumni Associations of no less than 15 schools. Upon his death in 1920, his ashes were laid to rest next to the ashes of his wife in a crypt under the new Allegheny Observatory. The epitaph was fitting: "We have loved the Stars too fondly to be fearful of the night." ■

Calc
Te

Today's sophisticated programmable continuous-memory pocket calculators have altered the old truths about lens design. In the past, only the experts were able to calculate the passage of light rays through a lens system. Now anyone with a little practice operating a calculator can do the required computations. If you don't mind reentering data over and over for each surface of a design, then even the simplest calculators are adequate for the basic calculations of ray tracing of optical systems.

Of course, laborious and repetitive methods can discourage even the most enthusiastic worker, so before trying lens design it is advisable that your calculator have certain functions. If it has the following keys, ray tracing will be much easier: reciprocal (1/x); trigonometric functions; memory registers (as many as practical for the price of the machine); parentheses for internal storing of calculations (some calculators costing less than $20 have as many as 15 levels of parentheses); square root; and a method of entry that is easy to understand and widespread in use.

There are two methods of entry in calculators now on the market, the Algebraic Entry System (AES) and Reverse Polish Notation (RPN). The main difference between the two, for example, in calculating 2 times 3, is that the commands in AES are between the terms [2][x][3][=] but in the RPN the command is after the terms [2][enter][3][x]. Most RPN machines have four internal registers ("the stack"), one of which is displayed. Entries for future calculations enter the stack via the "enter" key which places the first figure in the stack. RPN has no equals key, but after commanding [x], the contents of the display register and first register "above" it in the stack are multiplied. This form of entry is far more economical of keystrokes and memory than AES, not to mention more logical in operation, so that those who use RPN are somewhat fanatical about its merits.

Unfortunately, Hewlett-Packard calculators are the only machines currently on the market using RPN. All other companies have opted for AES. My first two pocket calculators were the HP-35 and HP-25 machines. Once I learned how to use RPN, I found it was very convenient. However, several factors dictated my current AES machines — even though I would prefer having RPN if I had a choice.

Many publications such as *Optical Spectra* and *Electro-Optical Systems Design (EOSD)*, contain optical

ulators For
lescope
Design

programs for pocket calculators written in the AES nomenclature. It's easier not to rewrite the programs into RPN. Cost is another big difference: in selecting a calculator (in my case, a programmable machine), the discount price of a Texas Instrument TI-59 calculator and printer was about $335 while the comparable Hewlett-Packard calculator and printer was about double that.

Concerning the various programs for use with a pocket calculator, professional lens designer, David E. Stoltzmann of Honeywell's Systems and Research Center in Minneapolis, Minnesota has the following comments for the amateur:

Basically the current available programs range form "zeroth-order" thin-lens object-image relationships, to first-order paraxial ray traces, to meridional ray traces, to a third-order aberration image-quality analysis, to conic and aspheric skew-ray tracing, and even on to some specialized zoom systems design.

"Zeroth-order" refers to the basic object-image relationship of idealized lenses with no thickness, such as those given by Sam Brown. First-order properties are arrived at through a paraxial ray trace of thick lens elements, and constitute the system's focal length, f-number, magnification, back focus, and image height.

Third-order properties refer to the aberrations of the system, such as astigmatism, coma, lateral color, and the like. Real ray tracing increases in complexity from meridional rays (rays lying only in the plane of the paper), to skew rays (rays whose trajectories do not lie in any single plane), to either meridional or skew rays traced through conic (parabolas, ellipses, hyperbolas) or aspheric (e.g., a Schmidt plate) surfaces.

The simplest ray trace to perform is the paraxial ray trace. A "true paraxial ray" is a ray which propagates along a trajectory infinitesimally displaced from the optical axis. However, when deriving the paraxial ray-trace equations, it soon becomes apparent that the system's paraxial imagery actually only depends on the constructional properties of the system (element radii, thicknesses, and refractive indices), and not on the ray height (or slope angle) at which the ray strikes the surface. One can thus use the paraxial ray trace equations to trace rays at any angle, and not just those close to the optical axis.

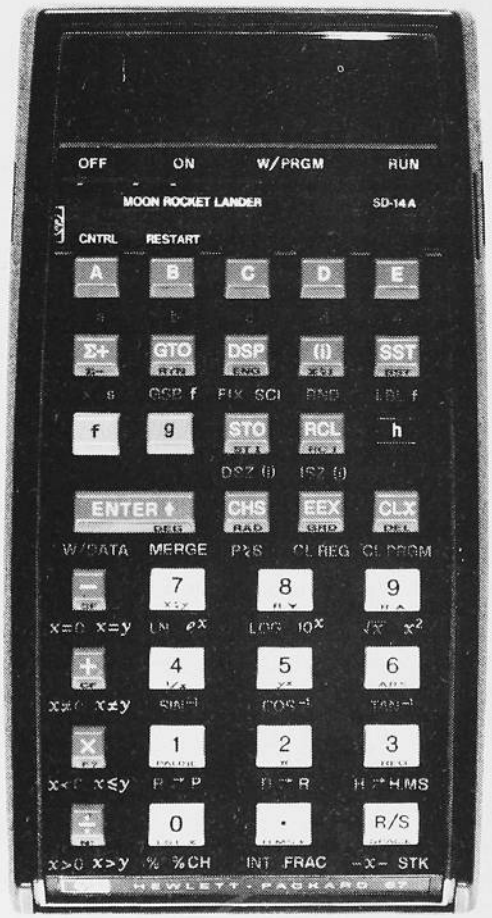
Incidentally, the paraxial ray-trace data are precisely the information used to compute the third-order aberrations of a system, as well as fifth-order,

"Being able to characterize [and minimize] these aberrations is what ray tracing and lens design is all about."

seventh-order, ninth-order, etc. (Third-order quantities are easy to compute; fifth-order and higher orders are very complex by comparison.) One can also use real ray-trace programs to trace a "true paraxial ray," but better use of these programs results from determining exact ray intersections on the lens elements (for element sizes) and the image surface (for ray aberrations). The difference between the image coordinates of the paraxial ray and that of the real ray is an "aberration."

Being able to characterize (and minimize) these aberrations is what ray tracing and lens design is all about. All of the above types of ray tracing can be done on a simple hand calculator. However, merely tracing rays will not make you a lens designer. Numbers alone cannot give you all the knowledge necessary to evaluate the quality of a design, especially if you think you've determined a system's quality after ray tracing it on-axis. Of course unless the axial quality is good, there is no reason to go on to the quality of off-axis image, so generally axial calculations are made first.

To indicate how deceptive the axial quality can be, note the figures given by Dr. Richard Buchroeder in "Cassegrain Optical Systems" (TM#1), where he points out the axial quality of the Dall-Kirkham design is good to 1/200 wave, more than sufficient for the strictest observer. However, when you consider fields off the axis, you find the image quality is markedly inferior to other compound systems using two mirrors.



Calculations involving skew rays, before the birth of the electronic calculator, were very limited and in many cases not done at all. Today, tracing skew rays is standard practice, in fact, imperative to good lens design. But this form of analysis involves more complicated mathematics, and a background in calculus and geometry are certainly a help.

Anyway, it is not often advisable to jump right into skew ray tracing. Many designers perform a simple paraxial ray trace, followed by a meridional trace, then apply certain formulae to calculate the expected errors or aberrations of the system, and then, and only then, when the formulae indicate only small errors remain in the design (remember: no lens is perfect) is the task of exact ray tracing on a calculator begun.

I recently heard that one of the best known lens designers, whose programs for calculating optical systems are widely used, uses such formulae on a simple TI-59 programmable calculator and printer before he starts final "tuning" of the design on a large computer! Calculation of the Seidel aberrations using the Buchdahl Aberration Coefficients is advisable before going beyond the simple paraxial and meridional ray trace routines!

* * * * *

Certain standards must be met in preparing and documenting programs for pocket calculators so others can apply them. First, the listed program should be checked many times to be sure it is the same as the one in the owner's machine and no errors are present. Second, always give the formulae with which the program was written. It is most annoying to see a program for a calculator that has to be modified to be used with the machine owned by one

"However, merely tracing rays will not make you a lens designer."

receiving the program. But without the formulae, this can be an almost impossible task! Although most machines use the AES program method, they do differ in the way entries are made in the specific machine. It is not always possible to simply copy a listed program into a calculator.

In examining several catalog listings of pocket calculators, the number of machines well suited for ray tracing was at least 25. Prices ranged all the way from less than $20 (discount price), to over $1,000 for a machine that had an added printer, extended memories, magnetic card reader, etc. The companies examined and the machines listed in the catalog were:

- Hewlett-Packard machines 41C (top of the line); 33C; 34C; and 67 (a desk-top machine similar to the HP-67 is the HP-97).
- From Texas Instruments there were the following calculators: 30SP; 35SP; 50; 55; 57; 58C; and 59 (the last two can be attached to an accessory printer).
- Sharp has five calculators of interest: EL5100; EL5101; EL5813; 505 and 506.
- Casio machines included: FX100; 68; 3500; 310; 6100; 501P; 502P.

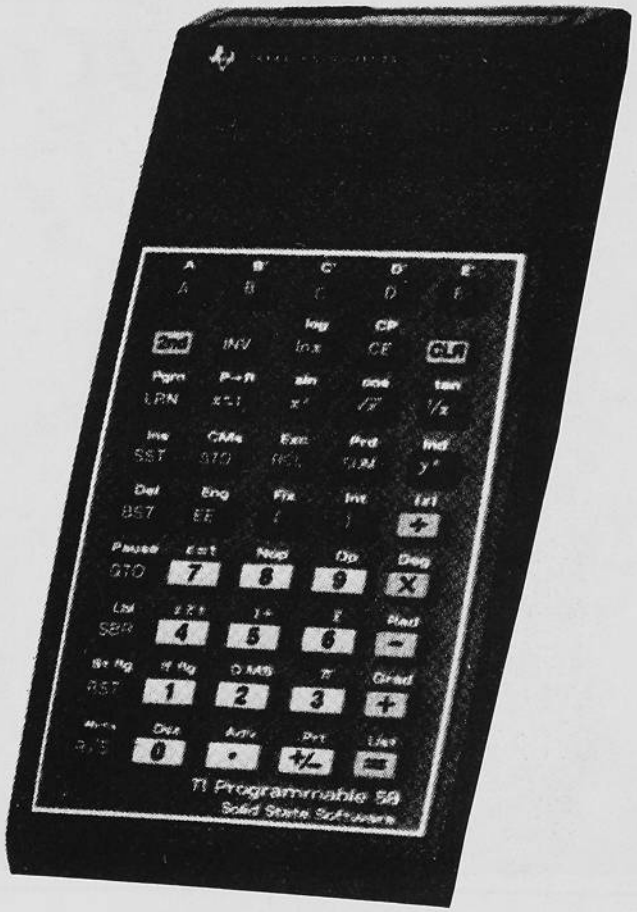
The "P" indicates programmable machines. The Casio FX502P is an unusual machine that is selling discount at about $90 which has 256 programmable steps and 22 memories with the capability of putting programs and memories on a tape recorder for storage and recall with a special adapter selling for less than $40. It has the convenient feature of continuous memory, so when the calculator is turned off, the program and memories are saved in the machine. Another good feature is about 1500 hours of battery life from two small silver oxide batteries.

If you wish to include simple four function calculators (which can be used by recording with pencil and paper necessary figures between calculations), then the list in machines would become many times longer than that above. Not included were minicomputers such as the TI-99, the Radio Shack TRS80, and many others.

Robert E. Cox and
David Stoltzmann

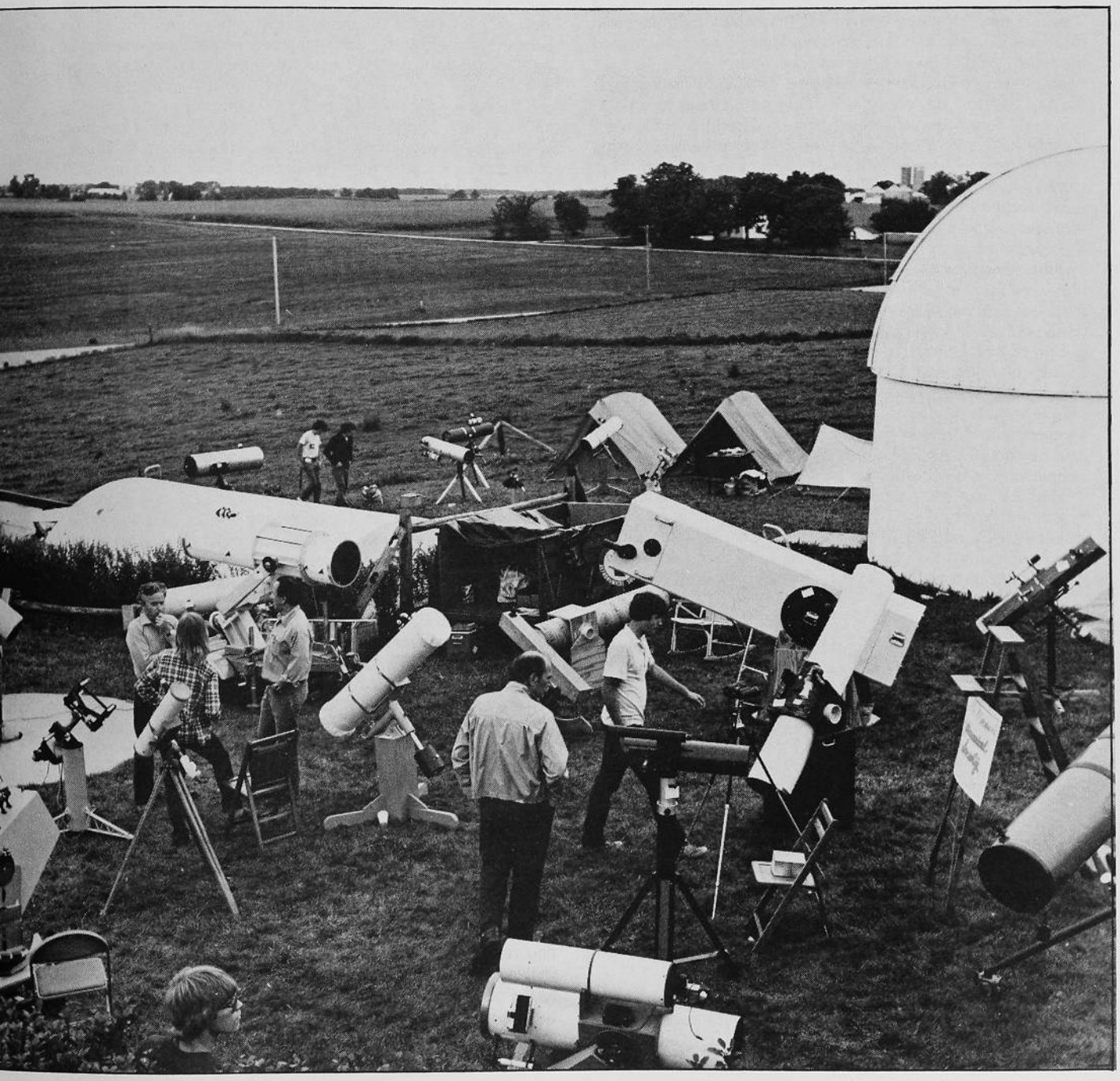
IMPORTANT: Although TM is interested in programs for pocket machines, we are not interested in ANY optical system design unless it has first been built and tested in actual operation. Paper telescopes are fine on paper — but they must be born of glass and hard work to prove out their capabilities as a safety measure to our readers. If the design looks good, and you're not a glass-grinder yourself, we'll help you find someone who can build the prototype instrument — then you'll have a design to be proud of.

As mentioned at the beginning of this material, anyone can — with time and patience — do lens design on a small calculator, up to a certain point! It is one thing to be able to put figures in a calculator and get answers displayed — but it's entirely another story to be able to adequately interpret the results and know what to do if they are not proper. I am sure even the most experienced lens designer breathes a sigh of relief after one of these designs has been prototyped and tests out to specifications. Calculators and humans are not infallible, hence our policy of only publishing prototyped and field-tested designs.



ASTROF

EST 1980



ASTROFEST 1980

As we drove down the last few miles of country road toward the 1980 Astrofest (held on Friday evening, September 5 at the Modine-Benstead Observatory in Racine, Wiconsin), Ele and I wondered what we'd find. Would anybody have shown up? Would the Racine and Chicago Astronomical Societies find, surely to their great distress, that telescope making was "dead" in the midwest? I'd left work a bit early, hooked the new trailer to the car, loaded in the telescope, fed our cats, remembered a hundred important but forgotten vital details, and gotten off to a start at least an hour late. Then we'd stopped for dinner, and now with twilight rapidly advancing, I knew setting up the telescope was going to be difficult in the dark. Oh, well, the best laid plans of mice and astronomers....

Then there it was — a stubby dome silhouetted against the evening sky — and zillions of cars and pickups and campers and telescopes all around it! Astrofest wasn't going to be a washout at all. We drove up the hill, unhooked the trailer, and Ray, Frank, Jerry, and Pete from the Milwaukee group helped me roll the trailer over to a small level spot.

There were telescopes everywhere. That night I saw at least 30, and the next day counted 50. I lugged the telescope parts out, and there were helpers in plenty to assemble it. Ele went looking for a spot to pitch our tent, and came back reporting that the tenting space was almost all used up and that there were lots of mosquitoes. I'd already noticed.

We went over to the observatory to register and ask about tent space. It was getting dark, and I wanted to get the tent up, the eyepieces and charts out, and start observing.

John Allseits was manning the registration table. All around him were cans of OFF! spray. He looked slightly frantic, but filled out our registration badges and offered us a chance to douse ourselves with bug repellent. Obviously, coping with a million organizational details was getting to him. I said that it looked pretty orderly and well organized to me. He said that he was worried they wouldn't be able to find lemonade for 200 people tomorrow. I said I was amazed — lots of people had showed up and the event was already off to a rousing start. He said he thought Astrofest was a good idea. I agreed. Clearly people were enthusiastic and happy.

The sky was clear, and overhead the Milky Way looked bright and pretty. I put on my mosquito-proof long-sleeved jacket with a hood, tied it close around my face, then got out the observing ladder, the eyepieces, and pretty soon had M-13 at 80x. I didn't take long for a line to form either, so I never had the chance to spend much time observing myself, but the skies were good, and the bugs tapered off about an hour after the end of twilight.

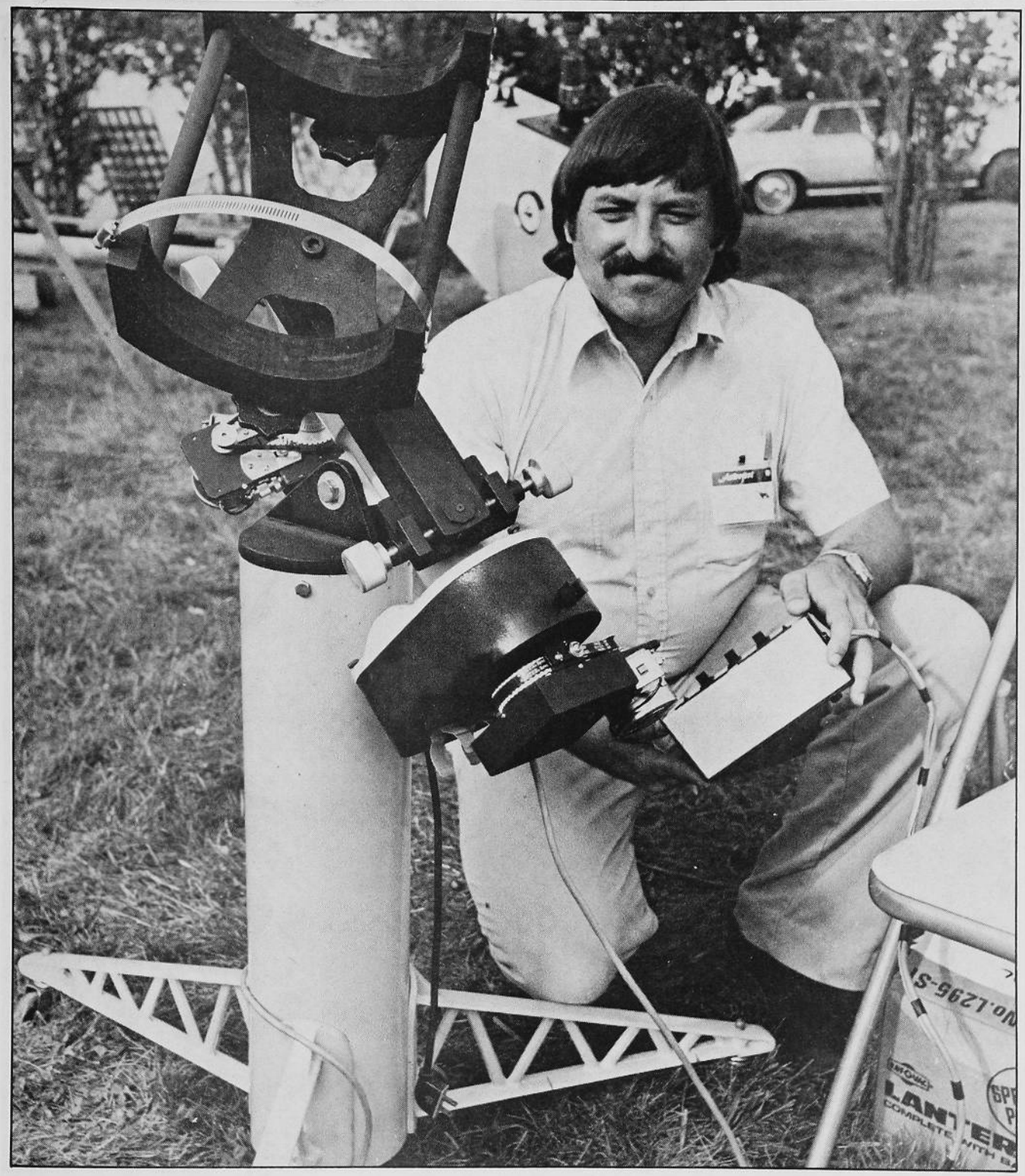
I don't know who it was, but someone from Chicago had a nebular filter mounted on a surplus eyepiece, and happened to bring it over while we were observing the Cygnus Loop. He suggested we try it, and the results were stunning: I've never seen so much detail in the Loop. The sky through it was a velvet black, and the nebulae appeared undiminished in brightness. I pulled a square yard of black cloth over my head to block stray lights and hogged the view. Not only was the segment that passes through 52 Cygni and the Comma filled with spectacular fine structure, but the little triangular patch and the Hickey were both visble. To see it all, you had to scan the telescope around the sky over several 40 arc-minute fields of view. The owner of the filter said it came from the Chicago Science Center, and it was whatever they had been selling at the time he bought it. Wherever it came from, it was a good one.

Observing went on until about 1:30, when an intermittent fog began getting things too wet to continue. The next morning dawned bright and sunny, but too soon. Under the tent, coffee, donuts, and Racine kringle (you didn't know about kringle?) were served at 9 a.m, accompanying the camping breakfasts and scrambled eggs many people cooked themselves. More or less promptly at 9:30, Dan Joyce of the Chicago Astronomical Society, Jim Felbab of the Racine Astronomical Society, and John Allseits made their opening remarks, introducing the program for the day and welcoming the 200 or so people then present (many more showed up during the day). The talks got off to a start in building #3; under the tent, cold drinks and lemonade materialized as the day began to heat up; and, under a little tent in front, the flea market opened for business. For the kids and non-astronomers, there were to be science fiction films and free popcorn.

I examined lots of telescopes that day, some of which are shown in the accompanying photographs. There were telescopes with beautiful hexagonal wooden tubes, five or six Dobsonians (incuding a very nice 10-inch f/6 one made by George McCourt), Dan Troiani's twin 10-inch and 6-inch rig, and John Paul's massive 16-inch. The most unique telescope was unquestionably Al Woods' 6-inch Tri-Schiefspiegler. Mounted on a Dobsonian on Poncet equatorial table, driven by a threaded rod running against a plywood gear, imaging via a high performance unobstructed all-reflecting optical system, and sporting conveniently placed observing lights, map clips, and an eyepiece rack, this was no telescope to sneeze at. The drive looked especially interesting because it's something lots of people might be able to build. He cuts a semicircular disk of plywood with 1 to 2% smaller radius than a simple calculation of the radius would indicate. He coats a threaded rod with chassis lube grease, then coats the edge of the plywood with Duro E-POX-EE. He warms it to start it setting, then, when it's no longer sticky to the touch, bends the threaded rod over the sector and clamps it until the epoxy sets. Since the threads on the rod will be compressed slightly (by 1 to 2% if you're lucky), you'll get a gear that runs at the correct rate. Meanwhile, I must admit to being very impressed with the image that an unobstructed aperture can deliver.

One of the highlights of the forenoon was looking through a tiny refractor equipped with an H-alpha filter. Prominences, visible at the rim of the solar image, shone around a penny used as the occulting disk. The other highlight was viewing Venus in the daytime through a 4-inch refractor. Atmospheric detail on the planet, normally hard to see because of its glare, was readily visible.

33➤



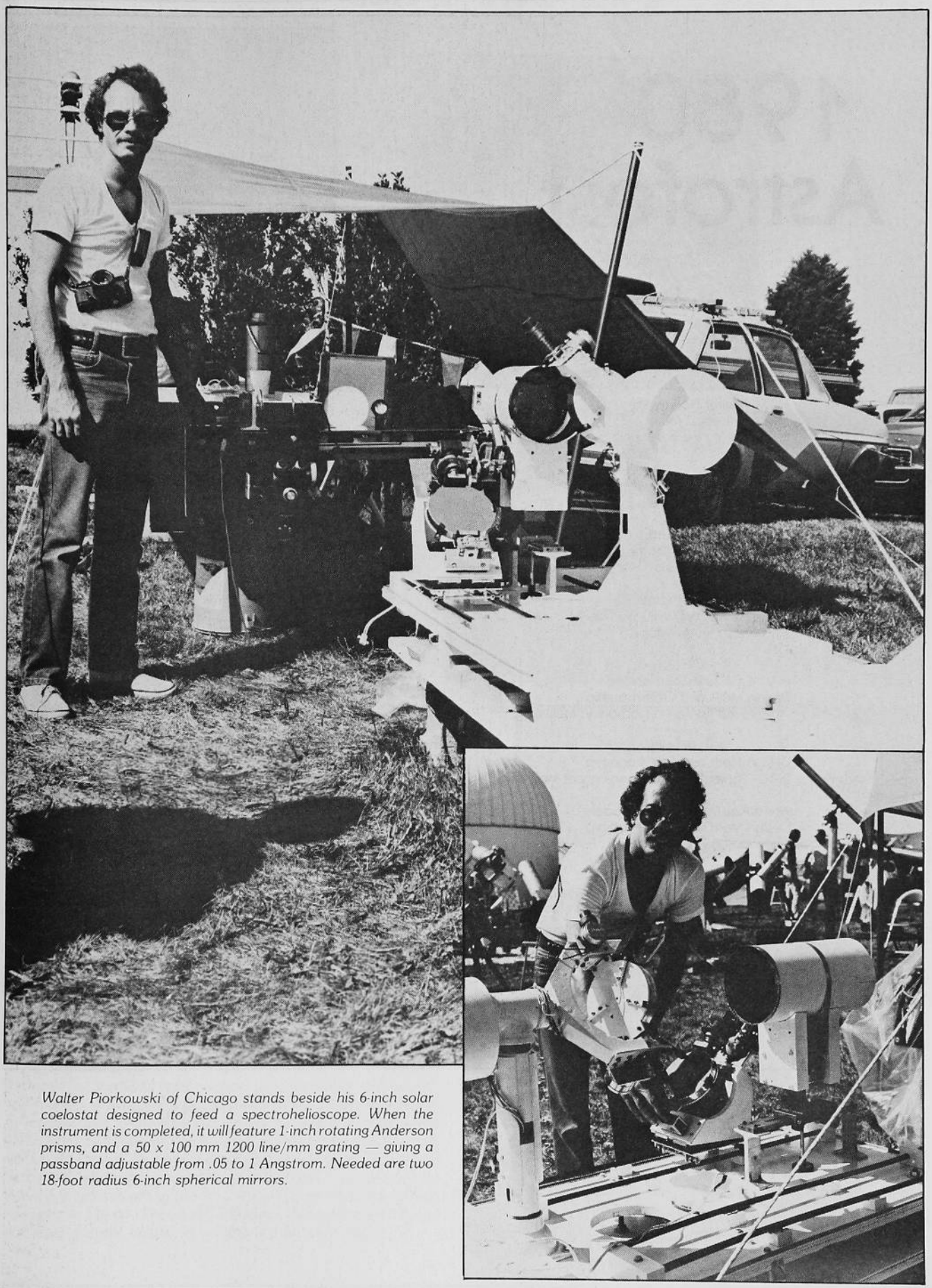
A. L. Woods of St. Louis displayed his 6-inch f/14.7 Kutter Tri-Schiefspiegler on a Dobsonian mount riding on a Poncet table. This instrument performed remarkably well on the double-double Epsilon[1],[2] Lyrae, splitting it with a wide dark space, and gave a crisp and pleasing view of M-31 with a lower-power eyepiece. The telescope is easy to handle, and the tracking was good enough that the double sat squarely in the center of the field for ten minutes or so (I didn't try longer). Of the Tri-Schief, the builder said, "They'll work well if you make 'em to the formula."

Robert Arthur of Grafton, Wisconsin, presented a computer-controlled equatorial mounting with digital position indication that slews to a preset position. It's based on the Fairchild F8 microcomputer, and uses optical incremental encoders on both axes. There are 2160 steps in declination and 1440 in R.A., yielding settings accurate to about 10′ in declination and 1 minute of time in R.A. The belt drives looked a little dubious to me, but the system — Synchro-Power timing belts driven by a Hurst 1rpm motor — apparently works quite well.

"Big" is the word for John Paul's 16.5-inch f/7 catadioptric Cassegrain telescope. Designed for astrophotography, this telescope, now nearing completion, uses a spherical f/3 primary mirror, a spherical secondary, and four individual corrector lenses about four inches in diameter to give a wide flat field. The optics were made by Phil Hopkins in California. The mount is quite massive, and is all Paul's work. "It's like a battleship," he admitted, looking at the 3/16" rolled tube, the heavy shafts, and the massive 18.5-inch drive gear. The telescope weighs 2000 pounds.

Robert H. Schmidt of Richfield, Michigan, looks through his 6-inch f/5.3 Newtonian. Based on the design of some of the world's largest telescopes, this homebuilt scope offers the observer a comfortable eye (and neck) position. It is driven by a 6-inch Byers worm gear drive. Most of the parts were scrounged from a scrap box or adapted from other uses.

ASTROFEST 1980



Walter Piorkowski of Chicago stands beside his 6-inch solar coelostat designed to feed a spectroheliоscope. When the instrument is completed, it will feature 1-inch rotating Anderson prisms, and a 50 x 100 mm 1200 line/mm grating — giving a passband adjustable from .05 to 1 Angstrom. Needed are two 18-foot radius 6-inch spherical mirrors.

1980 Astrofest

David Rank, Jack Osbourne, and Neal Jern
(Lick Observatory)
for the Anna L. Nickel 40-inch Reflecting Telescope
for "use of the ATM spirit in professional astronomy"

Walter Piorkowski
Design Merit
6-inch Coelostat and Spectrohelioscope

Ronald G. Giles
Craftsmanship and Design Merit
4.5-inch f/16 Cassegrain with a 63 mm Finder

Carl Buzzard
Unique Design and Craftsmanship
12.5-inch Dual Newtonian/Cassegrain with 6-inch Guidescope

John D. Phelps
Design Merit and Craftsmanship
8-inch f/5 Newtonian

Richard Berry
Largest Telescope on Site
Design Merit and Craftsmanship
20.5-inch f/4.9 Newtonian on a Dobsonian Mounting

A. L. Woods
Design Merit and Craftsmanship
6-inch Kutter Tri-Schiefspiegler on Dobson-Poncet Mounting

Milwaukee Astronomical Society
Design Merit and Craftsmanship
10-inch f/5.6 Newtonian "Portascope" on Fork Mounting

Robert D. Arthur
Design Merit and Craftsmanship
4.25-inch Telescope on Computer-controlled Mounting

Paul Lind
Design Merit and Craftsmanship
8-inch f/4.5 Newtonian and 6-inch f/16 Cassegrain Telescopes

George McCourt
Design Merit and Craftsmanship
10-inch Newtonian on a Dobsonian Mount

George Campbell
Design Merit and Craftsmanship
4.25-inch f/4.5 Newtonian on an Alt-Azimuth Mount

Raymond Zit
Design Merit and Craftsmanship
14.25-inch f/4.8 Newtonian on a Trailer

Robert Schmidt
Exceptional Design: Craftsmanship
6-inch Rich-field Telescope

Roy Minnich
Design Merit and Craftsmanship
4.25-inch f/10 Newtonian Reflector

Dan Troiani
Design Merit
10-inch f/5.6 Newtonian on Mount
with 6-inch f/4.5 - f/18 Newtonian/Cassegrain

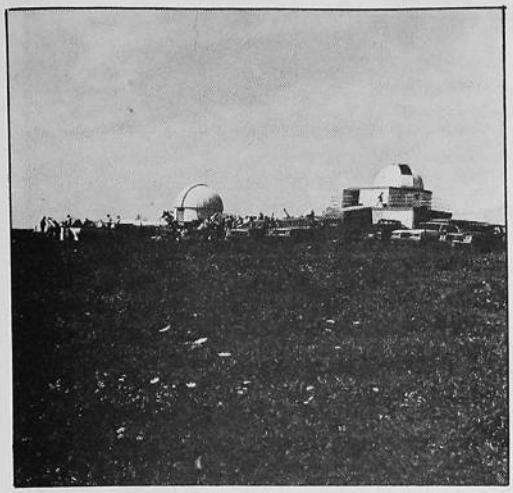
Marco Ricci
Design Merit and Craftsmanship
10-inch f/4.5 Newtonian - f/18 Cassegrain

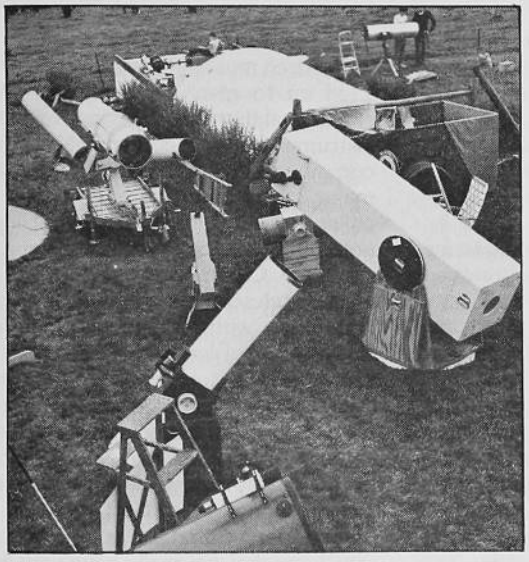
Joe Mayer
Oak Park-River Forest High School Astro/Physics Club
Outstanding Craftsmanship and Design
Three Newtonian Telescopes with Hexagonal Wooden Tubes

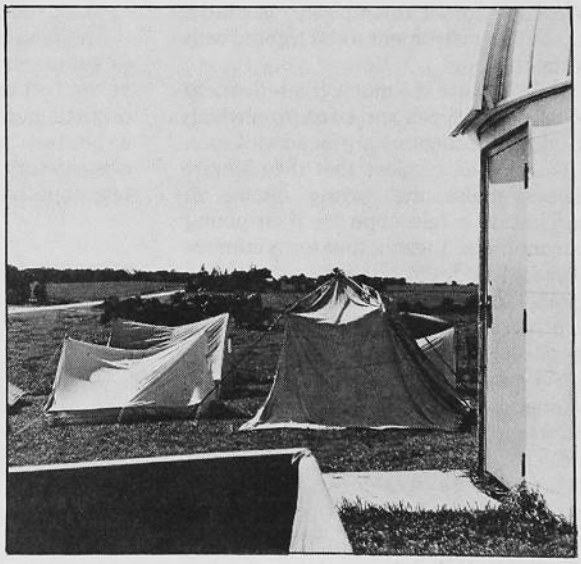
Peter Smitka
Design Merit and Craftsmanship
6-inch Short Focus Newtonian

Award Winners

ASTROFEST 1980







Over and over again I was asked about Dobsonian telescopes — especially those with 17.5-inch aperture. With several examples of the genus present, I suggested that "hands-on" experience is the best way to see what they can do, and ended up demonstrating with my scope what Dobsonians do well, as well as what their drawbacks are. At the 1981 Astrofest, I expect to see many large-aperture instruments. It is striking how many long-time observers, once they see what a portable telescope of 16+ inches can do, realize that "purely-visual" observing has a lot to offer.

We had great hopes for a clear Saturday night until fairly late in the day when high cirrus drifted in. Around five, everybody gathered for the BBQ buffet supper, evening talks, and awards and prizes (awards are listed in this article). Then the science-fiction and *Star Wars* films got underway, and telescopes were uncovered in hopes of clear weather. As darkness fell, a few stars tried for a while, then yielded to growing stormclouds and flashes of lightning in the west. I decided we'd better pack up and leave before getting the tent, the telescope, and everything else wet, so Ele and I headed for home. Next year, the Chicago and Racine clubs willing, Astrofest will be even better.

A Telescope for Children

What does a telescope have to do to arouse the interest of a child? Should it dance to music? Wear a happy face? Become sugar-coated? Act like a monster?

The idea of a telescope for children has been a concern of mine for some years. I remember my first telescope, a three-inch reflector that I've kept through twenty observing seasons, and which works more effectively now than it did the day I got it. I remember, also, the indescribable feeling of wonder and anticipation when I first looked at what to me was a telescope mightier than Palomar. I could see then that the telescope, for all its simplicity, was not a toy but an instrument to be treated with respect.

In 1980 there is a much greater variety of telescope types and sizes from which to choose. Educators are faced with such a cosmic sea of glass that they almost always make the wrong choice in purchasing a telescope for their young astronomers. I teach, and for a number of years I made wrong choice after wrong choice, until I started to realize that just as professional instruments are designed specifically for the needs of a research astronomer, a telescope should be planned just as carefully for the needs of his seven-year-old counterpart.

Each year, my young astronomy students were treated to a different instrument from my telescope collection. We tried an eight-inch reflector, a small Schmidt-Cassegrain, a refractor, and even a plastic working model of the two hundred-inch. All this time I watched their reactions, and it is from this experience that I developed Levy's Five Commandments for selecting a classroom telescope.

Keep in mind that I am concerned here with a telescope for the elementary school classroom. A private family might find some variation on these laws more suitable for their circumstances.

Commandment 1

Keep the design simple and basic. This limits us to a Newtonian reflector or refractor.

Commandment 2

Children like bigness, so the telescope should be fairly large. Just as I realized that my first telescope was not a toy, children should not be offered something so small that it could be a substitute for a tricycle.

Commandment 3

The telescope should be one that will be set up often. This is really a corollary of the first commandment and is based on the fact that most schools cannot be expected to have a permanent observatory. Stated differently, the telescope cannot be too big. It must be small enough to be portable so that a teacher will set up often.

Commandment 4

Children must not have to strain or be lifted up to reach the eyepiece. They should feel that they have control of the instrument, that they can reach it and commune with it. We should be trying to make astronomy easy and inviting for children, so it is important that children are comfortable with their telescope.

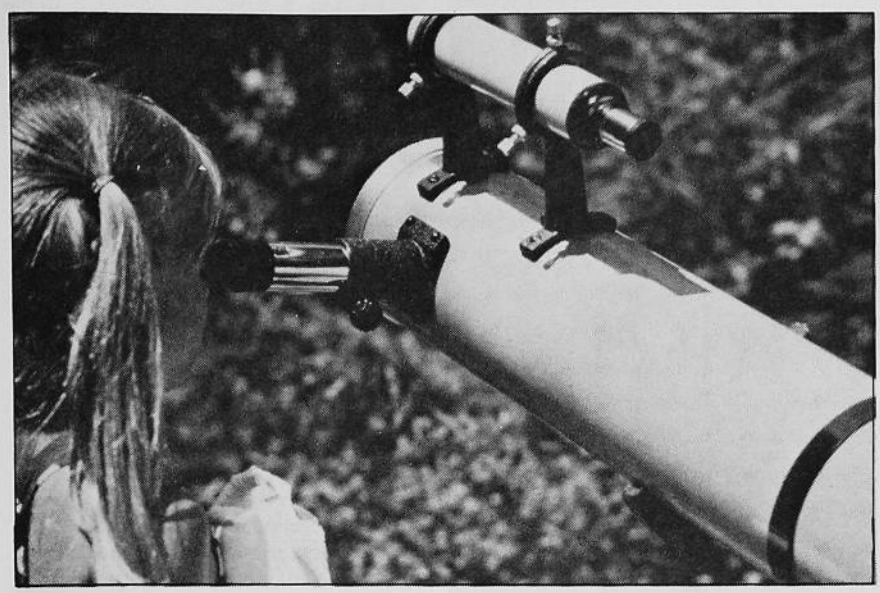
Commandment 5

The telescope should be rugged enough to withstand a thermonuclear explosion of at least thirty megatons.

Naturally a number of telescopes could satisfy these requirements. And if the school is fortunate enough to have more than one instrument, a second could satisfy more fully a different combination of these laws.

Considering the first three factors, you'll see that we really have very little freedom on telescope size. If it's smaller

Which is the right end? When you are learning about telescopes, the answer is both!



Even a four-year-old can look through Andromeda, the telescope, without stretching or having to be lifted up.

than three inches, a telescope violates the second law, and I've seen quite a number of 6″ f/8 reflectors that would violate the third. Combined with the first law, we're left with a compromise: a Newtonian reflector whose mirror is four inches in aperture. As an alternative, a three-inch refractor would do nicely if it were not so expensive!

With this in mind, I designed what could be an early step toward an ideal classroom telescope. Built by Constantine Papacosmas of Montreal, this is a four-inch f/10 reflector whose long focus emphasizes "nifty" views of the Moon and planets, gives adequate separation for the bright double stars, affords reasonable detail on clusters and bright galaxies, and still, with a low power eyepiece, can offer a good interpretation of a Milky Way star cloud.

The long focal length does involve a sacrifice of those richest field views we enjoy so much. I get around that by putting the finder to work! Why waste the possibilities of that perfectly adequate piggyback instrument? Accordingly, my finder is a peppy little twelve power, forty millimeter refractor that provides some stunning richest field views all by itself. The narrowness of the finder field limits its effectiveness as a finder — but remember that the whole instrument is to be used mostly for bright and easy-to-find objects.

The mounting is equatorial. I wanted it that way both for ease in keeping an object in the field and as an instructional aid. The tripod was adapted from an antique camera setup; it has an elevator bar in the middle, a feature which is most accommodating to commandment 4, in that the eyepiece can be adjusted to each child's height. The rotating tube also helps that way. As a final touch, the equatorial shafts are made from bicycle pedals, although I hope that the children will not ride away with their enthusiasm!

And let's not forget one of the most important things — if this is a telescope with a personality, it simply has to have a name! I chose Andromeda, and when a child asks why, the door is open to the beautiful mythological story of several fall constellations.

The telescope is so light that I can take it out several times in the course of the day. With its appealing bright green color, Andromeda always attracts the attention of the children whether or not it is in use.

School meets during the daytime. Many educators use this unalterable fact to excuse their total lack of any meaningful astronomy program. I use that same fact as a challenge, for the brightest star of all shines right outside the classroom window!

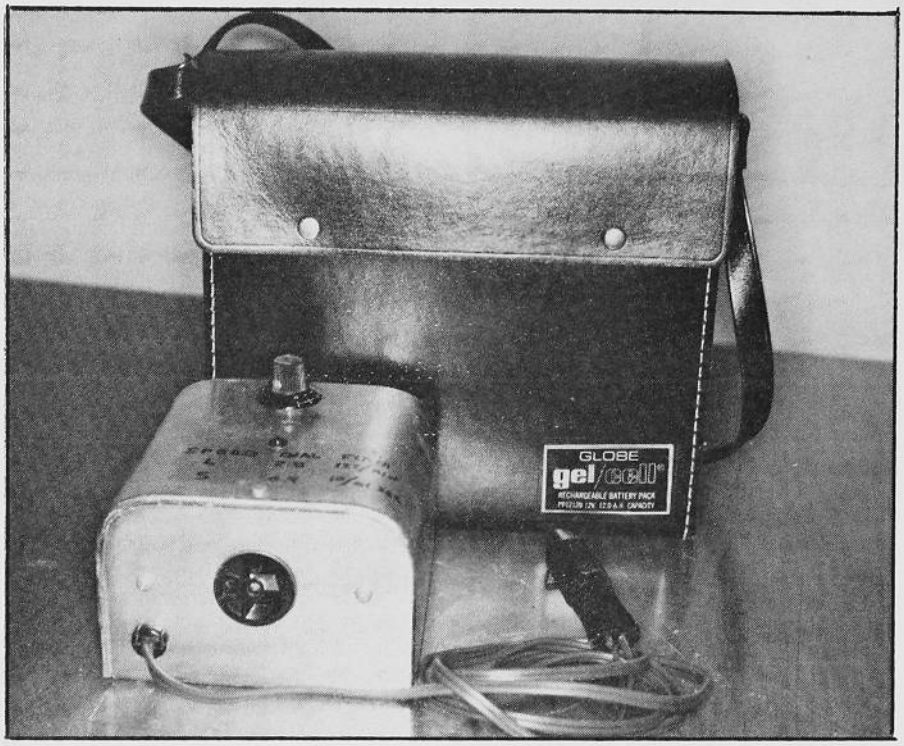
I don't use a solar filter for Sun observations with children for two reasons. The first is that filters are extremely dangerous and can be easily broken by a child. Second, if we use projection, we obviate the need for a long queue at the telescope. The children arrange themselves in a semicircle and they look at a large projected Sun. The operation usually does not last more than ten minutes, the telescope is easily carried out and in, and we can observe the Sun often as we watch a spot group's progress across the face of the nearest star.

Perhaps the most satisfying feeling comes at the end of a long night session with the children. When finally the last and most inquisitive nine-year-old has asked her last question and has gone off to bed, and all that's left is me and my telescope, I raise the elevator as high as it will go. The optical performance is good enough so that I now can begin a peaceful hour with observing variables, observing made even more satisfying with a thought that one of those little children may grow up to become a better astronomer than I'll ever be. And Andromeda — the children's telescope — may have provided that child with her very first cosmic view. Those thoughts make me smile.

David H. Levy
Route 7, Box 414
Tucson, AZ 85706

Studying terrestrial scenes is important in understanding and appreciating the function of a telescope.

A Basic RC Drive Corrector

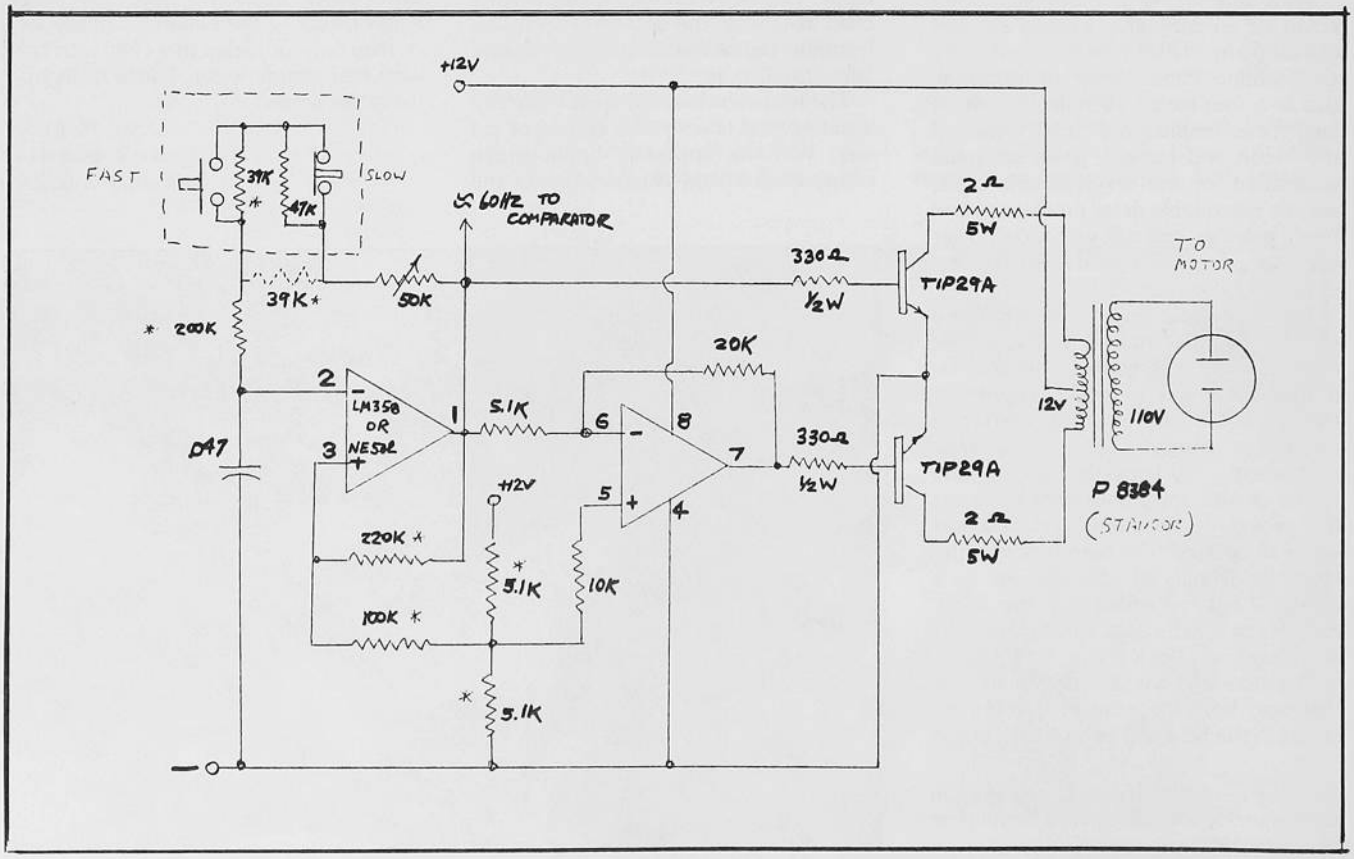


There have been any number of designs published for drive correctors, especially with the advent of integrated circuits. This one doesn't pretend to be revolutionary but is quite workable, of simple design, and is relatively inexpensive to build...particularly if you have any talent at scrounging parts.

The inverter consists of a typical R-C controlled oscillator fashioned from a dual operational amplifier IC. The complementary outputs of the amplifiers drive a pair of power transistors which in turn alternately switch the power to opposite sides of a reverse connected filament transformer.

A square wave of approximately 100 volts RMS is generated across the high voltage windings of the transformer. The exact voltage will depend on how much your telescope drive loads down the transformer. It is adequate for powering the dual drive motors on my C-8.

I use my unit strictly as an inverter, but by adding two push buttons and two resistors shown in the dotted box on the schematic, you can have a serviceable drive corrector.



Another option which I added is a frequency reference and comparator. It tells me if the inverter is running at the nominal frequency of 60 Hz. The reference is a crystal controlled 60 Hz oscillator which drives one input of a flip-flop. The other input is driven by the inverter's R-C oscillator.

An LED connected to the output of the flip-flop will blink at a rate equal to the difference between the two inputs. More on this later.

The power transistors must be attached to a heatsink such as the metal box I used. If you use a plastic box, be sure to enclose a metal heatsink of some sort for them. The transistors have to be electrically insulated from the heatsink and from each other by suitable insulating washers.

If you have 1% resistors around, use them in the oscillator circuit for improved stability. Ordinary 5% resistors will also work but may cause a bit of frequency drift when the temperature changes. The more critical resistors are marked with an asterisk on the schematic. It may be necessary to experiment a bit with the value of the 200K resistor to get the proper range of motor speeds with the 50K pot.

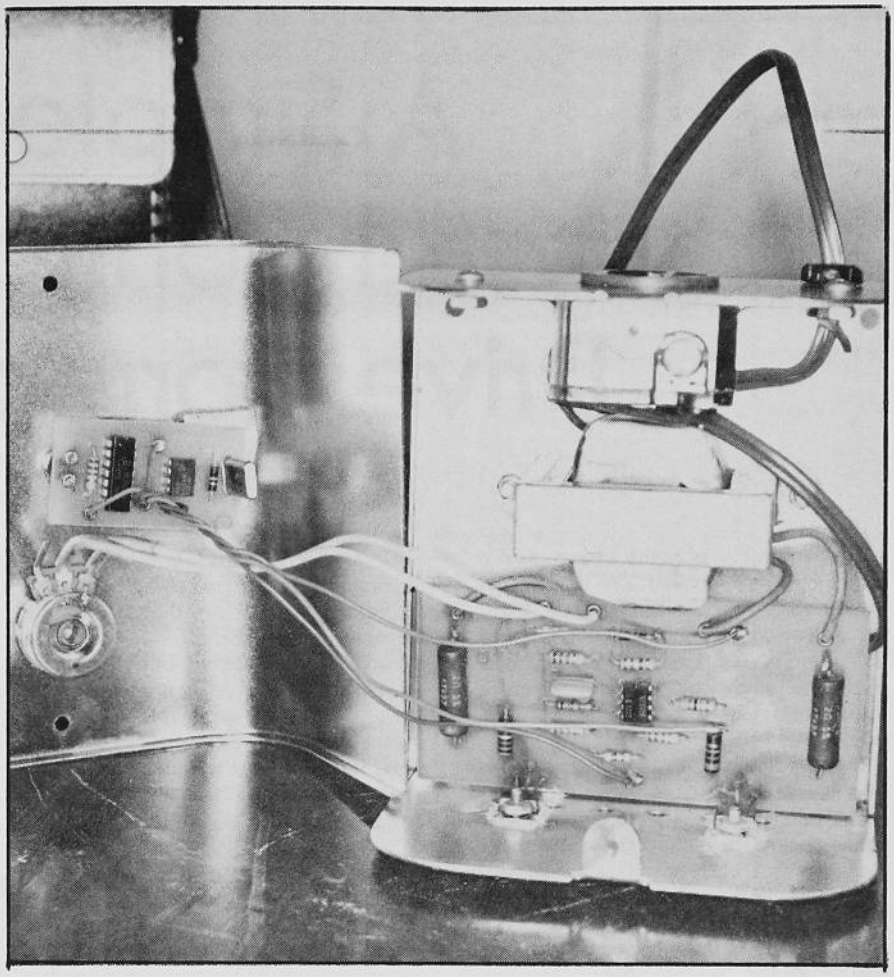
The crystal controlled 60 Hz oscillator uses a color TV crystal as a reference so the total price of this circuit can be quite low. In using the reference, set the pot so the LED is virtually either on or off all the time. This indicated that the motor is running at 60 Hz or solar speed. Turning the pot counterclockwise a bit (increasing resistance) will lower the frequency. Lunar frequency should be about 57.97 Hz which will be indicated by a flash rate of 122 flashes/minute. Sidereal speed is a bit clockwise from the 60 Hz position or 60.16 Hz. The flashing rate is 10 per 61 seconds. Mark these points on the dial.

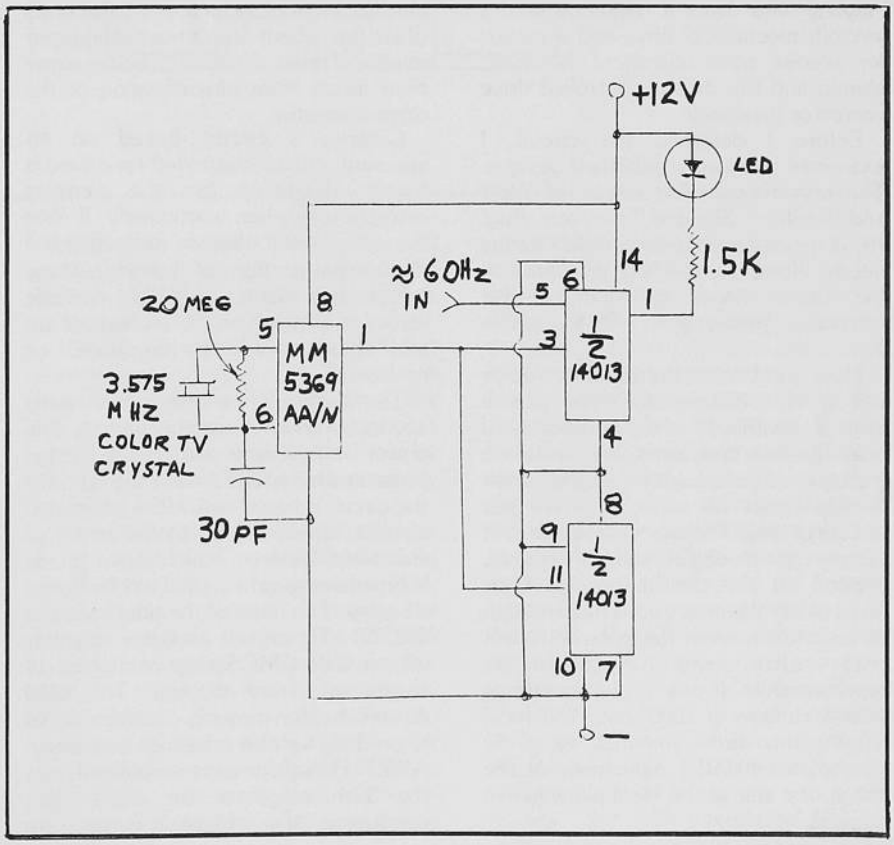
Don't test the inverter without having some sort of clock motor plugged into the socket. Leaving the socket open may allow the transformer to produce excessively high voltages which could arc over and damage the circuit.

The inverter is easily powered by any 12 volt source at about one ampere of current. I use a Globe-Union Gel/Cell 12 ampere-hour battery pack. It will run for hours and you can add an extra jack or a "Y" connector to the battery pack to run a second scope or to power a defogging gun. The battery pack is a recently released model which has improved performance and lower cost than the model it's replacing.

The inverter was demonstrated at the Racine Astrofest last summer.

James R. Bailey
N71 W26590 White Oak Drive
Sussex, WI 53089





A Simple Crystal Controlled Drive Corrector

For a number of years I have used a drive corrector based on the Saxon circuit (*Sky and Telescope*, Jan. 1975) for astrophotography. I live near city lights and must drive into the country to find dark skies, and therefore require equipment which is lightweight and portable.

For a visual observer, very little sophistication is necessary in the drive. The casual astrophotographer who relies on an approximate polar alignment and a commercially made telescope with large periodic errors in the drive may also find it a luxury, although it frees him from the necessity of periodic recalibration as the outdoor temperature changes. Anyone who owns a telescope with a smooth mechanical drive and a means for precise polar alignment, however, should find this crystal-controlled drive corrector invaluable.

Before I designed the circuit, I examined previously published designs. The crystal-controlled circuit of West and Bradford (*Sky and Telescope*, Aug. 1975) seemed needlessly complex for my needs. However, the R-C time base of the Saxon circuit is inadequate for astrophotography, even with a portable instrument.

How good must the drive corrector be? If, for example, the polar axis is aligned to within 10′ of the north celestial pole, the drift in declination of a star on the equator three hours from the zenith is only about 1.8 seconds of arc per minute of time. The exact amount of drift of any given object will, of course, depend on the declination and hour angle of the object as well as the direction of misorientation of the polar axis, but this value may be taken as representative. If one is photographing with a camera of 1000 mm (40″) focal length, this drift amounts to a 50 micrometer (0.002″) movement of the image of a star at the focal plane in five minutes.

On the other hand, it is difficult to maintain the calibration of an R-C circuit to better than about 0.5%, primarily because of temperature variations, but also due to the difficulty of obtaining an adequate calibration standard. However, an 0.5% error in the drive rate results in a tracking error of five seconds of arc per minute for a star at the celestial equator, or nearly three times the error due to a polar misalignment as great as 10′ of arc. Since it is not difficult to achieve a polar alignment of this accuracy even with portable equipment (in fact many astrophotographers routinely do much better than this), then assuming a smooth running drive with a periodic error of about five or 10 seconds of arc (i.e., about one or two seconds per minute of time), the major tracking error then arises from miscalibration of the drive corrector.

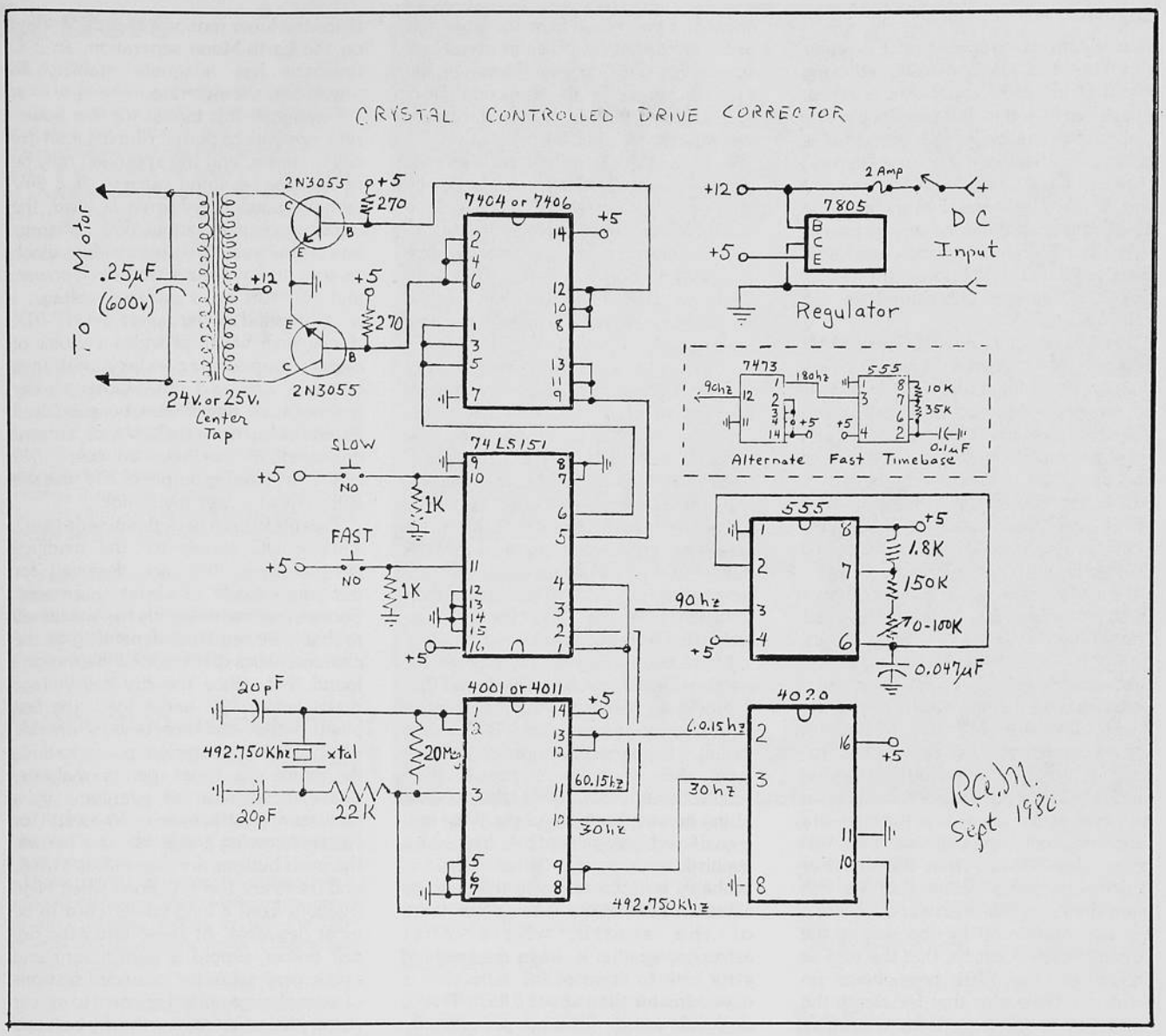
Clearly, a circuit based on an accurate, crystal-controlled time base is highly desirable for the serious astrophotographer...particularly if one has spent some effort in perfecting the mechanical portions of the drive. Many inexpensive worm gears have periodic errors of as much as 100 seconds of arc and these should be improved or replaced.

The desire for a simple but highly accurate drive corrector with a low power requirement led to the design presented here. The time base portion of the circuit is based on CMOS integrated circuits, which belong to the family of electronic devices which have made inexpensive quartz crystal wristwatches a reality. The heart of the time base is a 492.750 kHz crystal oscillator together with a 4020 CMOS chip containing 14 stages of binary division. The 4020 divides the high freqency oscillator signal to produce a stable reference frequency. A 60.15 Hz square wave is obtained from the 13th stage of the 4020 chip, producing the sidereal drive rate suggested by King in *Sky and Telescope*, Aug. 1975. (For a mechanical gear train which produces a true sidereal [rather than solar] motion using a 60 Hz motor, such as the Byers drives, the crystal frequency should be 491.380 kHz to produce the King drive rate.)

A 74LS151 chip is used to select the sidereal, fast, or slow drive rates. This is a data selector chip which is compatible with CMOS and which can select one of eight inputs, depending on the state of the address pins 9, 10, and 11. In addition, it provides the complementary outputs necessary to drive the power transistors. Normally, the 60.15 Hz signal is selected. If the slow button is depressed, the 30 Hz output from the 14th stage of the 4020 (pin 3) is selected, resulting in a tracking rate which is slow by 45 seconds of arc per minute. This is a convenient rate for astrocameras with focal lengths in the 400 to 1500 mm range.

A fast drive rate of 120 Hz can be produced by selecting the signal from the 12th stage of the 4020 (pin 1), but the torque of most synchronous motors is very low when run at this speed. Furthermore, this would result in a tracking rate which is fast by ¼ degree per minute, or twice the correction of the slow rate. Therefore I decided to use a 555 timer programmed to generate a 90 Hz square wave as the source of the fast drive rate.

The exact frequency of the 555 timer is controlled by adjusting the resistance between its pins 6 and 7. It is important to note that its resistance must be large compared to the resistance connected between pins 7 and 8 in order that the output pulses be symmetric. No such limitation applied to the Saxon circuit, where the 555 timer was followed by a 7473 flip-flop which has a perfectly symmetric output. The primary purpose of this flip-flop in the Saxon circuit, however, was to provide complementary



signals to drive the output stage. Since these are already available on the 74LS151, it may be eliminated.

Depressing the fast and slow buttons simultaneously selects the input at pin 1 of the 74LS151, and therefore the sidereal time base is also connected to this input in order to avoid disabling the drive under these circumstances.

The crystal oscillator is built around one gate of a 4001 quad "NOR" (or a 4011 quad "NAND") chip. Fixed-value capacitors are used, and no provision is made for fine tuning the crystal to the exact operating frequency since most amateurs will probably lack access to the equipment necessary to make this adjustment. Sufficient accuracy should be obtained with the circuit as shown.

Two other gates of the 4001 are used to buffer the output signals from the 4020. These buffer stages are not absolutely necessary, but since the gates are available, they are used in a conservative design. Note that all unused inputs (but not outputs!) of the 4001 and 74LS151 must be connected to ground.

CMOS chips similar to the 4020 but containing on-board circuitry for a crystal oscillator are available (e.g., the MC14451 which has buffered outputs). If one of these is obtained, the 4001 may be eliminated. The 4020 chip is more readily available, however.

The output stage is essentially similar to the design of West and Bradford. In place of the 75451 I have used a 7404, which is easily capable of sinking the current required to drive the 2N3055 output transistors. I have done this primarily to provide an alternative to the 75451 device, which is more difficult to obtain than the common 7404. The 75451 offers some simplification in wiring since it is contained in an eight pin package, and it can be substituted for the 7404 if desired.

Construction of this unit is straightforward, and even the inexperienced builder should encounter little difficulty. The CMOS chips are protected against damage from static electricity and require no special handling precautions. It is recommended that all ICs be placed in sockets. This not only facilitates troubleshooting should it ever be necessary, but also minimizes the danger of damage to an IC during construction. The major causes of failure in a simple project such as this are poor solder joints and incorrect (or missing) wiring. All circuit connections and IC positions should be doublechecked before applying power to the circuit.

One of the major objectives in this design was to use only readily available components, and, with the exception of the quartz crystal, all components can be obtained at Radio Shack or similar outlets. The 0.25 microfarad 600 volt output capacitor is best obtained from a

local electronics supplier or TV repair shop, but it can be approximated using two 0.47 uF, 250V capacitors in series. These can be found at Radio Shack. The high voltage rating of this capacitor is necessary to withstand voltage "spikes" created by fast switching of high current and needs to be at least 500 or 600V. The 20 pF capacitors can be approximated from two 47 pF units in series, and Radio Shack 115 watt NPN power transistors (276-2041) can be substituted for the 2N3055s.

I ordered my crystal from JAN crystals, 2400 Crystal Drive, PO Box 06017, Ft. Myers, FL 33906. It is currently priced at $5.95 including first class postage within the USA. Specify an output frequency of 492.750 kHz, a load capacity of 20 pF, and a tolerance of +/- 0.02%. This crystal is available only in an HC6U holder, and a socket (CE-1) is 20¢. I did not use a socket and soldered my crystal directly onto the circuit board.

I suggest constructing the circuit on a piece of perforated printed circuit "prototype" board such as Radio Shack no. 276-153. With this material, components and interconnecting wires are placed on the plain "top" side of the board with the leads extending through the perforations and soldered to the foil pads on the bottom side. Integrated circuits have a notch or indentation on one end of the chip, and the pins are numbered counterclockwise from this point when viewed from the top. For convenience, the circuit diagram has been drawn in this manner, duplicating the appearance of the top side of the circuit board — except that the pins as shown on the 7404 have been re-arranged. Note also that for clarity the 74LS151 is shown "upside down" relative to the other chips.

The power transistors should be heat-sunk to the cabinet. Since the case of these transistors is at a positive potential, it must be insulated from the cabinet using a mica washer.

My circuit was constructed on a 2½" square piece of circuit board, and the entire unit fits into a 2½" x 3" x 5" box. Construction is greatly simplified, however, if a more spacious parts layout is adopted, and readers are not encouraged to duplicate such miniaturization unless they have had considerable experience.

Using all new components obtained from local retail stores such as Radio Shack, the total cost of this drive corrector should not exceed $50, about $11 more than one with an R-C time base. The cost can be considerably reduced if the builder uses surplus parts or has a well-stocked junk box. Semiconductors are considerably cheaper if purchased from the large mail order firms that advertise in magazines such as *Radio-Electronics*. However, the total investment for the semiconductors in this circuit is not large even if they are bought at local retail stores.

It should be emphasized that the design is quite flexible and need not be built exactly as shown. For example, if you've already built a drive corrector of the Saxon type or the modification suggested by Koolish (*Sky and Telesope*, Dec. 1978), you can use the output stage of that circuit with the time base of the present design. Merely disconnect the leads from pins 12 and 13 of the 7473 in the old circuit and re-connect them to pins 5 and 6 of the 74LS151. In this case, it is convenient to obtain the fast (80 to 90 Hz) square wave from the old 555 and 7473 chips, together with the same resistors and capacitor previously used to generate the fast drive rate. It is merely necessary to remove the push buttons and associated resistors from the old circuit. A 90 Hz signal is then obtained from pin 12 of the 7473, as shown in the inset on the circuit diagram.

I have been using this drive corrector for about half a year and have found that it provides a significant improvement in performance over my old R-C based circuit. It is only slightly more complex to build than the Saxon circuit. This simplicity has been gained at the expense of the greater flexibility of the West and Bradford approach, but the sophistication of the latter circuit is probably not of interest to the average amateur. For objects within a few hours of the zenith, where most astrophotography is done, the tracking error due to atmospheric refraction is never greater than about 0.06%. This is negligible except for large permanently mounted instruments with extremely smooth mechanical drives, so the ability to compensate by adjusting the drive rate is not necessary.

The design does have one shortcoming, which may or may not be of importance. In an effort to simplify the circuit as much as possible, no attempt was made to provide a lunar drive rate. Using the sidereal rate, high resolution (three arc seconds or better) lunar photographs are possible if exposures are limited to a few seconds or less, which is sufficient in many cases. However, if required, an average lunar rate may easily be added by using a separate time base (e.g., a second 555 or half of a 556 dual timer) and connecting it to pin 15 of the 74LS151. This rate may be selected by a switch which applies a +5V potential to pin 9 of the 74LS151. If pin 3 is connected to pin 14 and pin 2 to pin 13, respectively, the fast and slow push buttons will work in the lunar mode. Since the lunar motion varies depending on the Earth-Moon separation, an R-C timebase has adequate stability to provide an average rate.

I designed this circuit for low power requirements to permit running it on dry cell batteries, and my approach may be of interest to some readers. If a 24V center-tapped transformer is used, the circuit consumes about 500 milliamps and produces a 120V output. Many clock motors do not require this much power, and will run on a reduced voltage. I accomplished this by using a Triad F-91X transformer which provides a choice of center-tapped secondary voltages between 20V and 40V. Other similar transformers would also be suitable. I found that by using the 32V taps, current consumption was reduced below 300 mA. The resulting output of 85V was still sufficient to power my motor.

Two 6V lantern batteries in series are a suitable DC supply for the modified circuit, since they are designed for maximum loads of about ¼ ampere. Some experimentation by the builder will probably be required, depending on the characteristics of the clock drive motor. I found that, since the dry cell voltage drops below 12V under load, the fast push button did not always operate reliably due to insufficient power to drive the motor at a faster than normal rate. This difficulty can be overcome by a number of strategies. However, for visual observing and public star parties, the push buttons are generally not used, and these are the situations when I find freedom from a long power cord to be most desirable. At these times the dry cell power supply is satisfactory and convenient, while for extended sessions of astrophotography, I connect to my car battery to avoid draining the dry cells and to ensure ample power throughout a long exposure.

Bob Mulford
1529 Valencia Road
Schenectady, NY 12309

Mr. Mulford adds that he is certain that Celestrons are solar rate drives since they have only two gears, but that Byers drives are sidereal rate drives. His own drive is a surplus 144-tooth worm wheel which he has re-bored to insure that it is properly centered. It has errors of about 15 seconds of arc as measured by Faix's method in May 1978 Sky and Telescope. *"It should be made clear that I am not disparaging the efforts of the 'casual' astrophotographer," he says; "rather I wish to avoid any undue expectations by pointing out that many telescope drives have mechanical errors larger than the improvement to be expected from a crystal-controlled oscillator."* ■

Letters

◄3

opposite direction and will nullify each other. Since a concave and a convex lens also neutralize each other's power, the diopter values of the lenses must be different." He also says, "If we correct the spherical aberration, we usually automatically correct the coma." It seems to me that if it works with lenses, it should work with mirrors. I would be interested if the curvatures could be worked out.

David Panariti
111 Imperial Hts. Dr.
Ormond Beach, FL 32074

Dear Mr. Panariti / We recommend **Modern Optical Engineering** *by Warren J. Smith and* **Lens Design Fundamentals** *by Rudolph Kingslake to you. To your first question: A corrector may be moved through the system and placed nearly anywhere for axial imagery. It may be placed on the surface of the secondary, or ahead of focus. To control off-axis imagery, however, it is concentrically placed.*

To your second: see TM#1 for an article on Cassegrain systems. The primary is ellipsoidal when the secondary is spherical: the secondary "cancels" some of the aberration from the primary, but not all of it.

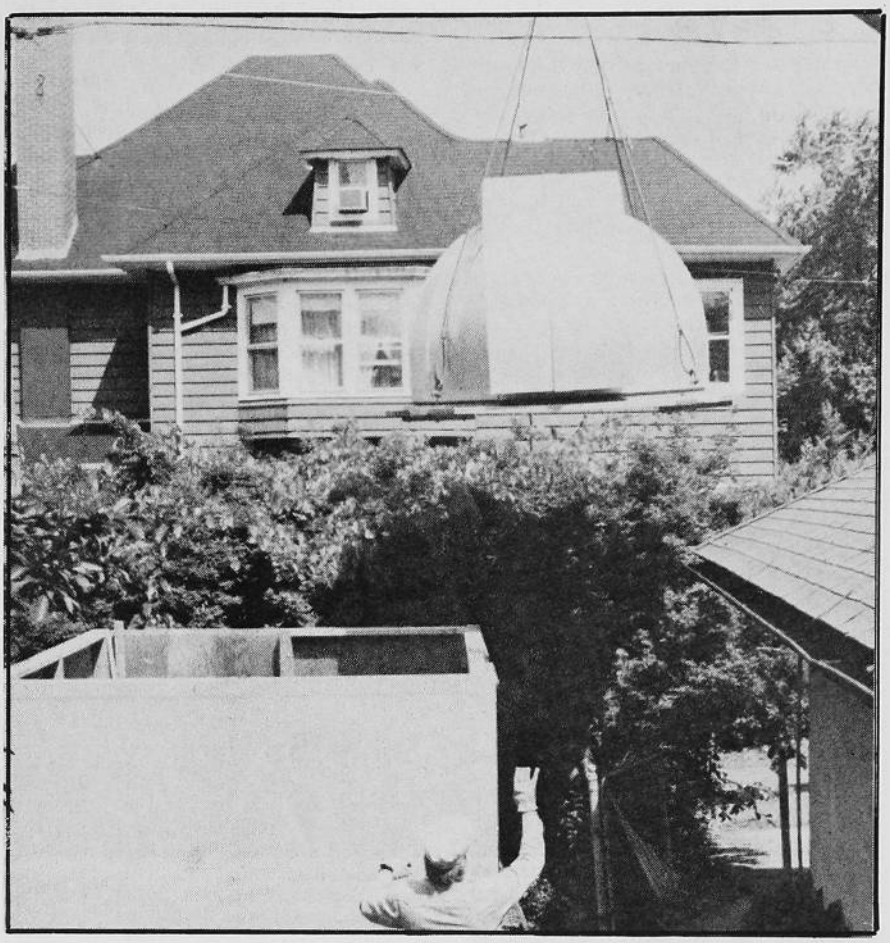
Remounting a Dobsonian?

Sir / "Fabulous" is the most appropriate description for Bob Kestner's Dobsonian articles, including the ones you ran in ASTRONOMY magazine. It gives those of us who are "less than affluent" an opportunity at a real telescope.

I have only one question: After the scope is built, will it later lend itself to being re-mounted on an equatorial mount or will the tube material and dimensions make it impractical for this application?

Frank N. Armeson
1329 S.W. Massini Avenue
Palm Bay, FL 32905

— If the mirror is mounted in a cell such as the one described for small mirrors down to 10-inch or 12-inch aperture, then remounting equatorially should be no problem. A scope with the sling-style cell cannot be used equatorially without modification. The tube for a Dobsonian is no larger than any comparable Newtonian.



Dome's Up

Dear Richard / Enjoying my subscription to TELESCOPE MAKING more with each issue. The coverage of Riverside had the necessary humor!

Enclosed snapshot shows the "redoming" of my 8' x 8' (plenty big enough for me) observatory with a 2-meter AstroDome for my ancient but beautiful Zeiss 8 cm refractor. The building was bolted together in case another move was necessary — good thing, too!

Keep up good work — pleasant observing.

Fred Matthies
Rancho Palos Verdes, CA 90274

TM Rejoining TMs

Sir / In answer to your editorial question in the last issue concerning advertising in TM, I

THE ASTROGRAPH

A Bimonthly Magazine Devoted to

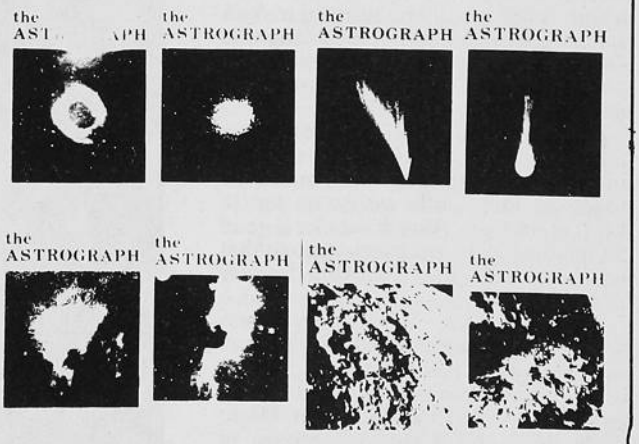
ASTROPHOTOGRAPHY

The **ASTROGRAPH** spans astrophotography from its basic principles to the techniques used by the most advanced amateurs. This publication brings its readers the details, construction, and photographic methods of pictures usually seen in other magazines as illustrations. If you are interested in astrophotography, seek to improve your photographic techniques, or desire to become aware of what others in this branch of astronomy are doing, this magazine is for you. Each year there will be one color issue devoted to color photography.

SUBSCRIPTION RATES

U.S. $6.00 per year • Canada and Foreign $8.00 per year

THE ASTROGRAPH • P.O. Box 218 • Dumfries, VA 22026



Letters

would like to indicate my agreement with your doing so. I know that this will improve the economics of the publication and it may also add to its appeal and interest.

It's been a long time since I ground a mirror (about 30 years!). Now entering retirement, I have the time to indulge in a hobby that has always interested me, and I have a lot of catching up to do.

I suspect that there must be lots of small companies out there unable to commit to funds for advertisement in the biggies. These firms still have good quality things to offer TMs and could reach the market through TM.

Please continue publishing and don't let my subscription lapse without notifying me.

Robert Becker
R.D. #1
La Fayette Road
Jamesville, NY 13078

— Thanks for the comments. We now mail out one notice with your last issue of TM and one final notice via first-class mail. Your best bet is to renew promptly with the first notice. We prefer two-year ($16) subscriptions because it's less paperwork.

El-Cheapo Tubes

Sir / Fiberglass makes a great telescope tube, and we are very fortunate to have access to it thanks to a company in Chardon, OH, called Structural Fibers. A lot of their tanks are rejected for one reason or another, so they sell them as scrap to an employee, Dan Roth, who lives in Rome, OH. His telephone number is (216) 563-3689. The prices he asks are very reasonable: 6-inch to 10-inch are $1.00 each, and 12-inch to 16-inch are $4.00 each. Bass Lake Community Inc. used to buy the scrap tanks but no longer does, They may still have the size you need, however you can call the office at (216) 285-9721, weekdays from 9 to 5. Their office is located just south of Chardon on Rt. 44.

The tanks make good tubes after the ends are cut off squarely. Since they're made for water softeners, they are very strong and are 100% fiberglass. The tanks can be purchased in various lengths, but for general purpose telescopes, you'll need to purchase at least two tubes — since their maximum length is 38". So, if you want to make a six-inch telescope with a focal length of 48" and at least 7" in diameter (inside) you'll need to add about 12" to meet the desired length.

I suggest that you cut 12" off of another tube, then put an epoxy bead on the edge of one tube standing up, and join the two together. Put a little weight on top to keep them tight. After it sets for a good 30 minutes, wipe off excess epoxy that has run down the tube with lacquer thinner.

Epoxy is one of the strongest adhesives known, and works very well with fiberglass. After it has set, fill any openings with more epoxy and let dry again. Next take some Green Magic Body Filler and a flat straightedge of rubber and just fill the groove, if any, around the tube. When that's dry, sand it with fine sandpaper. Epoxy paint makes a good covering for fiberglass.

from *The Valley Stargazer*
Earl Paullin
Chagrin Valley A.S.

Soften You Up

Sir / First, let me soften you up with a compliment. TELESCOPE MAKING is an excellent publication, by far one of the most straight-forward attempts at spreading specialized information to interested people.

Now let me tell you what I think of display advertising in TM. It just doesn't fit. I realize you are searching for a way to finance this publication — but please no glossy touched-up prints of commercial products. In this I am a purist: please keep completed products out of TM.

If the choice is between accepting advertising or discontinuing publication, by all means accept the advertising. Just try to maintain a low-key soft-sell approach or you will turn your readers off.

W. Foehringer
214 N. Maple Avenue
Sycamore, Ill 60178

— We printed our rules in TM#9 and intend to stick by them.

Sonotube Fixation

Sir / I recently purchased your "How to Build a Dobsonian Telescope" reprint. I found it quite handy, but there is one question I have: How do you fix up and paint Sonotube? It's got wax on it.

Chad Gates
197 E. Main Street
Orange, VA 22960

— There are three ways to go: 1) peel off the paper with the wax, prime and paint; 2) use a solvent to dissolve the wax, prime and paint; 3) put the tube in the Sun for a few weeks and the wax may melt or evaporate, then prime and paint.

Mass Production

Sir / From July 21 to August 1, 17 high potential children ages between 12 and 16 assembled for an Astronomy Summer Science Institute here at the University of Wisconsin, Eau Claire.

Besides academic studies, the children spent approximately 20 hours building telescopes. Six-inch f/8 mirrors from Coulter Optical were purchased for their Dobsonian alt-azimuth mounted Newtonian reflectors. We used plastic tubing normally used for plumbing as bearings and eyepiece holders. The tubes are square, made from 3/8" plywood, and the mirror cells are from 3/4" plywood with adjustable spring screws. All perform beautifully, showing stellar, nebular, and lunar features in excellent detail.

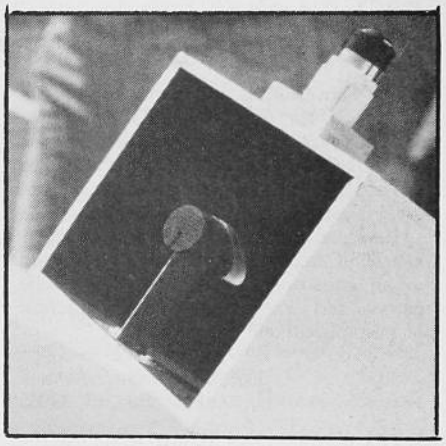
Enclosed is a photo of the group, with those telescopes available at the time of the photo. Your readers might be interested in seeing the results of a telescope building marathon.

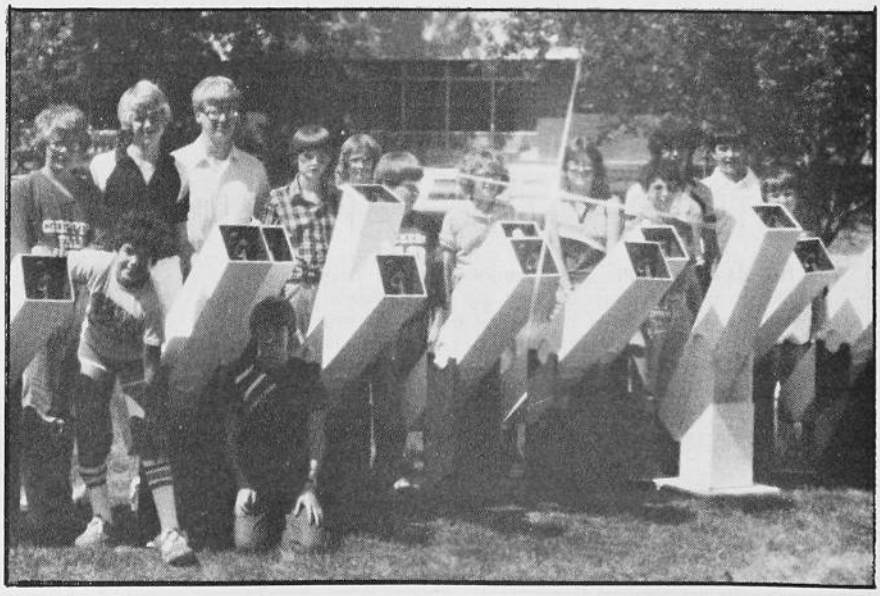
Roger E. Sahs
Rt #1, Box 171
Mondovi, WI 54755

— This really looks like a successful design. Such a project might be suitable for telescope making classes in a small to medium-sized astronomy club — a 6-inch f/8 Newtonian for less than $100 out-of-pocket expense.

Last Cave

Sir / Am I correct in my understanding that no articles have yet appeared about the design and construction of a cold camera for





astrophotography? I did not see anything listed on the back of TM#8.

By the way, it appears that I am the owner of the last Cave telescope to be fabricated. It is a 12.5-inch f/6 model "D". I did not receive it without my share of problems — including two or three trips to Long Beach.

Haley H. Haynes
4603 3rd Street
Greeley, CO 80631

Right — we haven't yet published a story on building a cold camera. The author is somewhere out there in "readerland."

Bowie's Dobsonian

Sir / Our new 14-inch f/5 Dobsonian was started as a club project by members of the Bowie Astronomical Society in October 1979. The mirror blank, of green plate glass, was obtained at a swap table set up during the 1979 MERAL convention in Harrisburg, PA.

Grinding started in the garages of Bud Ridley and/or Chip Hodges almost immediately, and was completed in early April 1980. After coating, it was installed in the Dobsonian mounting on Astronomy Day, April 26. The club had the telescope on display with other activities that day at the Bowie Public Library. Unfortunately, it rained all day, so no viewing was accomplished.

The telescope has proven to be a superb instrument: extremely stable, and optically very good. The 14-inch aperture provides excellent views, even with the light polluted skies near Washington, DC. This telescope has so intrigued me that I, personally, have started work on my own — a 12.5-inch.

There's a chip on one edge of the mirror, but I'm sure, once it's mounted in the telescope and put into use, the views will help me forget it is there — or so I keep reminding myself.

Walter E. Hamler
3508 Lisa Lane
Waldorf, MD 20601

16-inch Quotes

Sir / Thank you very much for assistance in reviewing the design and optics for the 16-inch f/3.5 Cassegrain telescope with 3x secondary. I thought it might help others to summarize my search for other sources — and thus make this information available. These quotes are good as of February 1980.

- SKY RESEARCH: $3500, 6 mos. lead time, primary at least 1/40-wave smoothness when using a 3.5 secondary.
- STAR LINER: $3625, 4 mos. lead time, 1/10-wave sodium light.
- STAR INSTRUMENTS: $2600, 3 mos., "we have the capability."
- CROSS OPTICS: $2300, 6 mos., optical surface limited by characteristics (anneal) of the glass.
- Gene Fair Custom Optics: $900, two mos. firm, optics 1/10-wave peak-to-peak or better, 1/40-wave or better RMS, can supply profile of surfaces. 8.5 years as Chief Optician for the Hale observatories.
- CUSTOM OPTICS: (Don Loomis) No bid because of work load.
- SIGMA RESEARCH: Their work done by Don Loomis. No Quote.
- COULTER OPTICAL: No present or future plans to make 16-inch mirrors.
- MEADE INSTRUMENTS: Do not offer custom finished mirrors.
- K. Novak: (Ladysmith, WI.) No quote.
- SUMMIT INSTRUMENTS: (Richard Ragin) "Interested," but did not quote.
- A. JAEGERS: Returned catalog only w/o quote.
- EDMUND SCIENTIFIC: Supplied catalog only w/o quote.

The above quotes are based on my supplying the blanks and the tool, and the vendor aluminizing and overcoating the finished optics.

My vote goes for Gene Fair unless a new and better source appears.

Edward A. Halbach
720 Ramshorn Drive
Longs Peak Rte.
Estes Park, CO 80517

Thanks for the info.

Expansionist

Sir / I'd really like to see bigger issues of TM because there are so many fields that a magazine like it could cover if it had the space and money.

One such article that I'd like to see is on square telescope tubes — anyone could then build a sturdy tube. I'm puzzled at how few square telescope tubes are now used. A flat surface on the side seems to be the perfect thing to mount a focuser on.

Well, anyway, I think you and everybody else on the TM staff are doing a great job of putting an excellent magazine together.

Carl Reimers
93 Gunderman Road
Ithaca, NY 14850

— Your editor is one of those who has built lots of square wooden tubes. I think they're

48 ➤

Blue Pages

Classified Product Directory

BOOKS/INFORMATION

Celestron International
2835 Columbia St., Torrance, CA 90503
(213) 328-9560

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

OPTICA b/c
4100 MacArthur Blvd., Oakland, CA 94619
(415) 530-1234

DRIVE ELECTRONICS

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, CA 92626
(714) 556-2291

DRIVE GEARS

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

DRIVE MOTORS

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

EYEPIECES

Celestron International
2835 Columbia St., Torrance, CA 90503
(213) 328-9560

Coulter Optical Co.
54121 Pinecrest Rd., Idyllwild, CA 92349
(714) 659-2991

Dodd Co.
7795 W. Ridgewood Dr., Parma, OH 44129
(216) 886-2828

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

Manitoba Museum Shop
190 Rupert Ave., Winnipeg, Manitoba, R3B 0N2, CANADA
(204) 956-2830

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, CA 92626
(714) 556-2291

OPTICA b/c
4100 MacArthur Blvd., Oakland, CA 94619
(415) 530-1234

Unitron Instruments Inc.
175 Express St., Plainview, NY 11803
(516) 822-4601

W.R. Parks
P.O. Box 6683, Torrance, CA 90504
(213) 532-6066

FILTERS

Celestron International
2835 Columbia St., Torrance, CA 90503
(213) 328-9560

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, CA 92626
(714) 556-2291

OPTICA b/c
4100 MacArthur Blvd., Oakland, CA 94619
(415) 530-1234

W.R. Parks Co.
P.O. Box 6683, Torrance, CA 90504
(213) 532-6066

LENS KITS

N. Remer Optics
Box 306T, Southampton, PA 18966
(216) 355-3086

LENS BLANKS

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

N. Remer Optics
Box 306T, Southampton, PA 18966
(216) 355-3086

LENSES — CUSTOM MADE

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

LENSES — OFF-THE-SHELF

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

OPTICA b/c
4100 MacArthur Blvd., Oakland, CA 94619
(415) 530-1234

MIRROR BLANKS

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

N. Remer Optics
Box 306T, Southampton, PA 18966
(216) 355-3086

When you build your own scope, you want to use the best materials available.

UNITRON offers the ATM the finest quality components and accessories for refractors, reflectors and catadioptric instruments. Choose from a wide selection of:

A EYEPIECE HOLDERS

For 24.5mm

Star Diagonal	$15.00
2X Barlow	8.00
Erecting Diagonal	36.00
Erecting Prism	30.00

For 1¼"

Star Diagonal	23.00
2X Barlow	23.25
Erecting Diagonal	40.00
Erecting Prism	27.00

B VIEWFINDER MOUNTING BRACKETS

For 23.5mm finder, pair	$ 8.00
For 30mm finder, pair	10.00
For 40mm finder, pair	13.00
For 60mm finder, pair	20.00
For 100mm guide scope, pair	45.00

C EYEPIECES

1¼" O.D.

40mm Mono	$25.00
20mm Erfle	40.00
25mm Ortho	31.00
18mm Ortho	29.00
12.5mm Ortho	27.00
9mm Ortho	28.00
6mm Ortho	29.00
4mm Ortho	32.00

24.5mm O.D.

25mm Ramsden	$16.00
18mm Kellner	16.00
12.5mm Kellner	16.00
9mm Kellner	12.00
9mm Symm	19.00
7mm Symm	19.00
6mm Ortho	24.00
5mm Ortho	24.00
4mm Ortho	27.00

D CAMERA ADAPTERS

Standard Adapter	$18.00
Deluxe Adapter	35.00

E T-MOUNTS

Pentax-K (Bayonet)	$ 6.00
Pentax (Thread)	7.00
Petri	13.00
Mamiya	8.00
Nikon	13.00
Exacta/Topcon	13.00
Konica	13.00
Canon	13.00
Minolta	13.00
Olympus	16.00

F VIEWFINDERS

Complete with mounting brackets

6X-23.5mm	$ 35.00
8X-30mm	45.00
10X-40mm	60.00
12.5X-60mm	148.00
8X-30mm w/diagonal	63.00
10X-40mm w/diagonal	75.00

G MULTIPLE EYEPIECE HOLDERS

For 24.5mm

Unihex rotary eyepiece holder	$56.00
Deutron double eyepiece holder	49.00

For 1¼"

Unihex rotary eyepiece holder	$56.00
Deutron double eyepiece holder	83.00

H MOUNTED OBJECTIVE

60mm f/8.3	$ 61.00
60mm, f/11.7	61.00
60mm, f/15	61.00
75mm, f/16	124.00
100mm, f/15	235.00

I OBJECTIVE OUTER CELL WITH DEWCAP

For 60mm Objective	$16.00
For 75mm Objective	24.00
For 100mm Objective	45.00

J PHOTOGRAPHIC GUIDE SCOPES

Complete with mounting brackets.

60mm, f/11.7	$152.00
75mm, f/15	285.00
100mm, f/15	548.00

K ASTRO CAMERAS

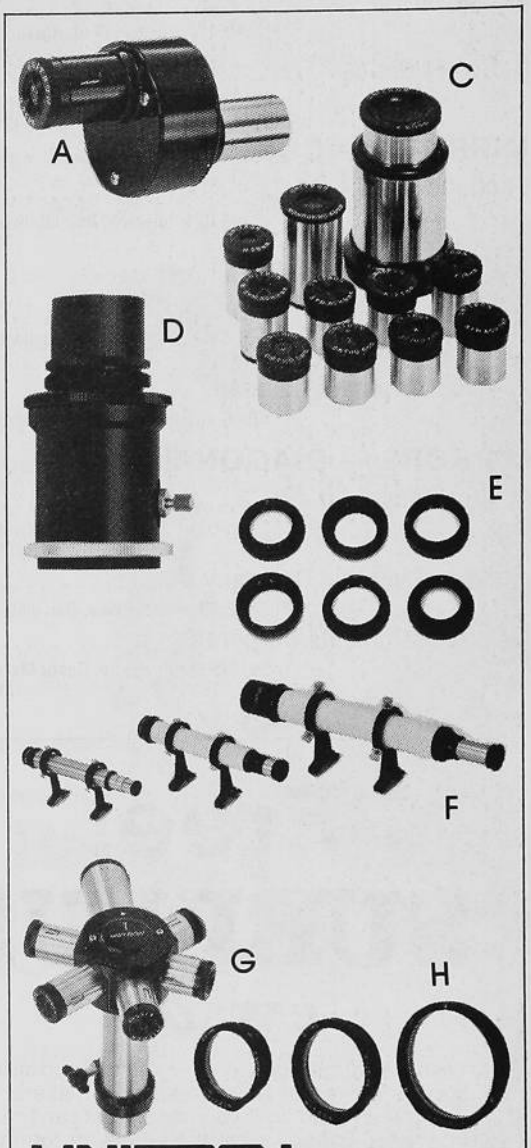
Model 220A, for Unitrons	$305.00
Model 220B, for 1¼" holders	305.00
80mm, f/5 Astrograph	715.00

L RACK & PINION FOCUSING MECHANISMS

Can be adapted to suit individual requirements.

Standard Model for 2.4" Refractors	$ 38.00
Standard Model for 3" Refractors	38.00
Deluxe Model	48.00
Super Model	100.00
Super Model with Focusing Scale	100.00
Coupling Collar for Deluxe Model, to fit 3 1/16" i.d. tubing	11.00
Coupling Collar for Super Model, to fit 4⅜" o.d. tubing	19.00

Prices, F.O.B. destination Continental U.S.A., subject to change without prior notice.



UNITRON

EXCELLENCE BY DESIGN

Send me more information about:

☐ _____

☐ Accessories catalog

UNITRON INSTRUMENTS, INC.
175 Express Street, Plainview, NY 11803, U.S.A.

TM.

master charge VISA

Name _____

Address _____

City _____

State _____ Zip _____

MIRROR KITS

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

OPTICA b/c
4100 MacArthur Blvd., Oakland, CA 94619
(415) 530-1234

N. Remer Optics
Box 306T, Southampton, PA 18966
(216) 355-3086

MIRRORS — CUSTOM MADE

Coulter Optical Co.
54121 Pinecrest Rd., Idyllwild, CA 92349
(714) 659-2991

MIRRORS — FLATS

Coulter Optical Co.
54121 Pinecrest Rd., Idyllwild, CA 92349
(714) 659-2991

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

MIRRORS — DIAGONALS

Coulter Optical Co.
54121 Pinecrest Rd., Idyllwild, CA 92349
(714) 659-2991

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, CA 92626
(714) 556-2291

Free!
SURPLUS
CATALOG

We have gadgets galore . . . industrial and military surplus items that all you telescope makers, gadgeteers, and do-it-yourselfers just can't afford to overlook. If you have the knack for turning a thing-a-ma-jig into a golden opportunity, then our gadget gazette is just what you're looking for. Have an idea that needs some unusual lenses, eyepieces, timers, motors or perhaps gears? How about mirrors, finderscopes, tubing, glass filters or some other such thing? We have the gadget you're looking for. Just send for our latest FREE catalog.

JERRYCO

Write To :

JERRYCO
5700 Northwest Highway
Chicago, Illinois 60646

OPTICA b/c
4100 MacArthur Blvd., Oakland, CA 94619
(415) 530-1234

W.R. Parks Co.
P.O. Box 6683, Torrance, CA 90504
(213) 532-6066

MIRRORS — OFF-THE-SHELF

Coulter Optical Co.
54121 Pinecrest Rd., Idyllwild, CA 92349
(714) 659-2991

Enterprise Optics
P.O. Box 413, Placentia, CA 92670
(714) 524-7520

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, CA 92626
(714) 556-2291

W.R. Parks Co.
P.O. Box 6683, Torrance, CA 90504
(213) 532-6066

MOUNTINGS — COMPLETE

Celestron International
2835 Columbia St., Torrance, CA 90503
(213) 328-9560

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, CA 92626
(714) 556-2291

Unitron Instruments Inc.
175 Express St., Plainview, NY 11803
(516) 822-4601

W.R. Parks Co.
P.O. Box 6683, Torrance, CA 90504
(213) 532-6066

MOUNTINGS — PARTS

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

OPTICAL ABRASIVES — BULK

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

OPTICA b/c
4100 MacArthur Blvd., Oakland, CA 94619
(415) 530-1234

OPTICAL TEST EQUIPMENT

Coulter Optical Co.
54121 Pinecrest Rd., Idyllwild, CA 92349
(714) 659-2991

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

PREFORMED TOOLS, LAPS

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

SETTING CIRCLES

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

W.R. Parks Co.
P.O. Box 6683, Torrance, CA 90504
(213) 532-6066

TELESCOPE ACCESSORIES

American Science Center
5700 Northwest Highway, Chicago, IL 60646
(312) 763-0313

Celestron International
2835 Columbia St., Torrance, CA 90503
(213) 328-9560

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

Manitoba Museum Shop
190 Rupert Ave., Winnipeg, Manitoba, R3B ON2, CANADA
(204) 956-2830

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, CA 92626
(714) 556-2291

Unitron Instruments, Inc.
175 Express St., Plainview, NY 11803
(516) 822-4601

TELESCOPE PARTS

Dodd Co.
7795 W. Ridgewood Dr., Parma, OH 44129
(216) 886-2828

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, CA 92626
(714) 556-2291

OPTICA b/c
4100 MacArthur Blvd., Oakland, CA 94619
(415) 530-1234

W.R. Parks Co.
P.O. Box 6683, Torrance, CA 90504
(213) 532-6066

Unitron Instruments, Inc.
175 Express St., Plainview, NY 11803
(516) 822-4601

TELESCOPE TUBES

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, CA 92626
(714) 556-2291

W.R. Parks Co.
P.O. Box 6683, Torrance, CA 90504
(213) 532-6066

TELESCOPES, COMPLETE

Celestron International
2835 Columbia St., Torrance, CA 90503
(213) 328-9560

Coulter Optical Co.
54121 Pinecrest Rd., Idyllwild, CA 92349
(714) 659-2991

Dodd Co.
7795 W. Ridgewood Dr., Parma, OH 44129
(216) 886-2828

Edmund Scientific Company
101 E. Gloucester Pike, Barrington, NJ 08007

Manitoba Museum Shop
190 Rupert Ave., Winnipeg, Manitoba, R3B ON2, CANADA
(204) 956-2830

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, Ca 92626
(714) 556-2291

REFRACTOR KITS

Anyone who can grind and figure a mirror can make an objective lens. The remarkable image quality is ample reward for the effort.

We have assembled kits of first-quality materials to build a diffraction-limited air spaced achromatic objective of 3" or 4" aperture.

Kits include crown and flint lens blanks, glass tools, abrasives, polish, templates, specifications, and detailed instructions to advance the amateur through the art of lens making. Lens cells and tubing are available to complete your telescope.

We also carry mirror kits and optical supplies at competitive prices.

Catalog/price list available. Please send 25 cents to:

N. REMER OPTICS
Box 306T
Southampton, PA 18966
(215) 355-3086

Hand Figured Telescope Mirrors

Null Tested
Aluminized and Overcoated
Sizes: 4¼" to 16"

10" F-6 Mirror $165.00
12½" F-6 Mirror $275.00

Also Available:
Mirror Kits • Telescope Parts

FREE
Complete Product Price List
On Request

ENTERPRISE OPTICS
P.O. Box 413
Placentia, CA 92670
(714) 524-7520

Letters

◄43

great, and have used them for my 20-inch f/5, my 12-inch f/7, an 8" f/10, and a 4-inch f/10. There isn't much to them — just a reinforced square box. RLB.

Poncet Solution

Sir / I'm afraid you have done Steven Veit a disservice in your response to his letter in TM#9. A Dobsonian telescope on a Poncet mounting will handle essentially all of the features Veit cites — though not necessarily as elegantly as a professionally designed and built assembly. Your article on the Poncet mounting in TM#8 makes this point clearly.

Perhaps you should have recommended that, coincident with starting his savings program, he undertake to build a 6-inch Poncet-Dobsonian. By the time his $1200 is in hand, he will have had enough experience to make a rational decision on his own whether (a) to proceed with building a 10-inch Poncet-Dobsonian, or (b) to go whole-hog on a complete store-bought rig, or (c) to do something else — like using the money for college.

Something else he should recognize is that a 2.5-inch telescope should serve very well for astronomical viewing. After all, Galileo's telescopes were even smaller. Maybe Steven's is out of adjustment or, perhaps, of insufficient quality for reasonable performance.

F. A. Upson
7032 Hohman Avenue
Hammond, IN 46324

— The Dobsonian-Poncet combination is not yet a reality. To the best of my knowledge, no one has yet taken first-class deep-sky photos with one. If Mr. Veit had any TM experience, I would agree with you wholeheartedly. But for a beginner whose knowledge comes from reading the ads, it's too experimental. I do expect to see the "breakthrough" sometime this year — it's bound to happen sooner or later.

Two Comments Taken Together

Sir / I read with great interest the TM#9 "Letters." I feel inspired by two separate topics presented — separate, though related. Thus a quick note of comment.

First, advertising in TM. I applaud all the readers who responded negatively to advertising in the issues of TM. I believe this to be a majority opinion. We subscribe because it is "The magazine for, by and about telescope makers." Advertising supportive to this concept would, of course, be beneficial to many readers — particularly those of us who do not have the skill or equipment to fabricate all components of many interesting designs presented in TM. This seems to be happening with your plan to diversify the "Blue Pages" to include display ads. Can we keep it that way? Will printing them be at the expense of content? Will ads become repetitive in character? Will we see redundancies? Your challenge lies ahead as it has in the past. Certainly it's more complicated than balancing a checkbook!

Second, programming. Mike Jones brought up a part of TM that happens to be one of my prime interests, namely, computer application to optimization in telescope design. I would love to obtain a listing of his programs. I am experienced in FORTRAN and have just purchased the HP-85. Consequently, conversion of his programs would take minimal effort.

In spite of my desire to see listings in TM, I wonder if they would be counterproductive to the intent of TM. Even in *Kilobaud MICROCOMPUTING*, there is discussion of using space to print entire program listings, and a strong push is underway to limit listings to only those routines within a program that contribute new understanding and that are pertinent to the topic of the article. Listings of programs that perform significant operations are necessarily voluminous. Can TM afford the space? Is there enough interest among readers of TM to warrant introduction of a column devoted to this topic or enough for an occasional listing? Could your next survey of readers include a related question? Or would interchange of listings through "Letters" be the best approach in the case of infrequent interest?

As you can see, both of the above are related. They both deal with the question of relevancy of content for TM readers. TM is jam-packed with stuff relevant to what we are interested in. Your leadership has made this possible. And I see a bright future for this to continue.

Clear skies and/or happy reading to us all.

Darryl J. Davis
953 Ordway
Albany, CA 94706

Sir / I'm happy to see that you plan to publish some computing programs for us optics enthusiasts. However, as you've already acknowledged in an answer to a letter in the Fall issue of TM, it would be hard to publish any but a few relatively small programs.

I'd like to suggest that you publish instead a list of mailing addresses of people who have those programs and a description of programs they are willing to contribute by mail for the price of postage and material. In this way you could help readers establish a very effective pool of programs for various machines and purposes. Some very interesting new designs and testing techniques might come of such an effort.

William McKinley
3822 Shelby Road
Lynnwood, WA 98036

— Thank you readers Davis and McKinley for saying what you've said. Yes, program listings would take up too much space and worse, too much time to prepare for publication. I haven't even had time to glance over the programs that have arrived, but clearly their volume would displace other significant articles. We will set up some kind of exchange page for programs and the serious ones can swap programs. Ads may help readers, but they do reduce content until we have more than 48 pages. We are restricting size, location, and content in an effort to avoid the worst effects. I hope that ads in TM will help more than hurt, but the camel has its nose in the tent. ■

DEEP-SKY OBSERVERS!

GET MORE OUT OF YOUR OBSERVING!

DEEP-SKY MONTHLY is the monthly magazine intended for the deep-sky observer. It's the only place you'll find clusters, galaxies, and nebulae reviewed in depth, month after month, for your observing satisfaction. It's chock-full of sketches, excellent amateur astrophotos, charts, and scientific vital statistics that will help you every time your turn your telescope to the sky.

DEEP-SKY MONTHLY's feature articles cover observing techniques, scientific knowledge about deep-sky objects, special objects of interest, variable stars, and deep-sky astrophotography techniques. Regular monthly departments cover double stars, clusters, nebulae, and galaxies. Whatever your deep-sky observing interests, you'll be pleased with **DEEP-SKY MONTHLY.**

Start your subscription today.

$9/year USA - $12/year elsewhere

photo by Jack Newton

DEEP SKY MONTHLY, INC.
A Non-Profit Corporation of Deep-Sky Astronomers
104 Oakhill Drive, Oxford, Ohio 45056
Dave Eicher, Editor Telephone (513) 523-5554